

CALIFORNIA
ENERGY
COMMISSION

**2004 Annual Review of the PIER Program
Volume 3 – Industrial-Agricultural-Water
End-Use Energy Efficiency
Project Summaries**

STAFF REPORT

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Arnold Schwarzenegger, Governor

**CALIFORNIA
ENERGY
COMMISSION**

Gary Klein,
Project Manager

Ron Kukulka,
Acting Deputy Director
**ENERGY RESEARCH AND
DEVELOPMENT DIVISION**

Robert L. Therkelsen
Executive Director

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IAW Multi-Year Projects Started in 2004

Assessing Risks and Benefits of Drinking Water Utility Energy Management Practices

Contract #: 500-03-025 **Project #:** 2

Contractor: American Water Works Assoc Research Foundation

Subcontractors: Stratus Consulting : McGuire Environmental Consultants : Summit Blue Consulting : Bren School of Environmental Science and Management

Project Amount: \$262,500

Match Amount: \$440,716

Contractor Project Manager: Jennifer Warner (303) 734-3422

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The objective of the project is to develop, demonstrate and convey a practical risk-benefit decision framework to enable water utilities to:

1. Identify and assess the risks and benefits of a broad array of energy management options including both energy supply and energy demand alternatives.
2. Apply practical risk management tools to help them select, explain and implement suitable energy management and risk mitigation practices.

The technical approach will be to:

1. Conduct an early canvass of water utilities to identify the most important types of energy management issues and strategies.
2. Apply risk management principles to develop a decision framework suited to evaluating and mitigating potential downside risks of water utility energy management strategies.
3. Conduct a hands-on workshop with participating utilities and PAC members to help refine the framework and define training/technology-transfer needs.
4. Apply the decision framework to two complete case studies.
5. Develop a guidance manual.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity, and improving the environmental, public health, and safety of California's electricity by developing, demonstrating and conveying a practical risk-benefit decision framework.
- Improving the reliability, quality, and sufficiency of California's electricity by identifying the most important types of energy management issues and strategies.

Proposed Outcome:

1. Produce a guidance manual for utilities that will contain a comprehensive risk management framework that will help them identify, assess, and manage (or mitigate), all downside risks to water supply and water quality associated with energy management strategies.

Project Status:

Stratus Consulting won the Request for Proposals issued by AwwaRF and the Commission is to implement the project. The project will begin on April 1, 2005 and be completed on December 1, 2006.

Demand Response Analysis and Tool Development for IAW End Users

Contract #: 500-02-014 **Work Authorization #:** E2I-WA-116

Contractor: Electricity Innovation Institute

Project Amount: \$394,248

Contractor Project Manager: Ellen Petrill (650) 855-8939

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Active

Project Description:

To build an infrastructure for demand response programs, it is critical to understand how end customers select and respond to individual demand response programs. Encouraging end use customers to modify their load based on the demand needs of the electrical grid has the potential of providing significant improvements in T&D system reliability and stability.

The Energy Commission has ongoing demand response initiatives that are addressing research areas in the application of demand response initiatives with commercial buildings in California. While many of these efforts are directly relevant for the industrial, agricultural and water (IAW) end users, there are many areas unique to the IAW community that are currently not being addressed. The Working Group 2 (WG2) formed under the CPUC Ruling R.02-06-001 is actively involved in defining and assessing ongoing efforts in the area of critical peak pricing (CPP), demand bidding (DBP) and real time pricing (RTP). Evaluation of the initial data by WG2 shows that several of the early adopters of the CPP and DBP are IAW end users. However, the overall end user participation in CPP, DBP and RTP pilot or tariff programs is much lower than originally expected. Thus it is imperative that these segments be actively analyzed for their ability to participate in the demand response programs.

The Energy Action Plan, Integrated Energy Policy Report and the initial publicly released priorities of the new governor all indicate that DR is a key element of future energy actions and policies. The IAW community represents over 30% of the energy used by the State of California and IAW end users represent a very large potential for future DR related energy load reductions and DR energy management programs. Representatives of the PIER IAW Staff routinely interact with the IAW community and have established a very productive working relationship with several industry associations and key end users throughout the State. During these interactions, several key areas of desired research always surfaces from the IAW end user community:

1. What is the business impact of a specific new DR pilot or tariff on the business operations of a specific IAW end user? To what extent can these business impacts be generalized across a class of IAW customers?
2. What interactive analysis tools can be developed to assist prospective IAW DR Participants to better understand the benefits and costs of new DR pilots or tariffs, and are these analysis tools likely to be accurate enough to be useful in encouraging appropriate decisions by individual IAW customers?
3. What results of existing IAW DR programs can be shared with other IAW end users to encourage them to more actively participate in future DR pilots and tariffs?

This project is completing research to obtain a better understanding of the decision factors industrial and agricultural end users apply when determining if they will or will not participate in future demand response tariffs and initiatives. Of specific interest in this effort is defining some of the key business financial decisions that must be made to understand the costs and benefits of active participation in specific DR programs such as CPP, DBP and RTP.

This project supports the PIER Program objectives of:

1. Improving the reliability/quantity of California's electricity by encouraging end customers to participate in demand response programs thereby reducing overall demand on the electrical grid during peak demand hours.
2. Improving the energy cost/value of California's electricity by providing end customers new energy pricing options that permit them to meet their electrical needs and lower total energy costs.

Proposed Outcomes:

1. DR survey report for industrial and agricultural businesses.
2. DR business tool for industrial and agricultural businesses with supporting documentation.
3. Final report on the results and lessons learned during project.

Project Status:

End user surveys, tool development and report preparation will continue into 2005.

Development of a Utility Energy Index to Assist in Benchmarking of Energy Management for Water and Wastewater Utilities

Contract #: 500-01-040 **Project #:** 2

Contractor: American Water Works Assoc Research Foundation

Subcontractors: CDH Energy Corporation

Project Amount: \$125,000

Match Amount: \$208,334

Contractor Project Manager: Linda Reekie (303) 734-3423

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The objective of this project is to produce industry-wide energy performance metrics to describe the performance of water and wastewater utilities, which will subsequently be incorporated within a comparison framework (benchmarking tool) to facilitate internal and external comparisons within and between utilities.

The approach will be similar to the US EPA's Energy Star program that makes energy performance comparisons in commercial buildings. The Energy Star program allows building owners and managers to compare the energy performance of their building with similar buildings on a national basis. Building owners and others can self-assess their building energy performance with a few readily available building and operational characteristics: utility energy use, floor area, employees, computers, and hours worked per week.

This methodology will serve as the basis for developing a comparison framework for water and wastewater utilities. First, the contractor shall separate the impact of gross plant configuration from that of energy management/plant operations. Once the variability associated with the various energy intensive processes has been removed, the contractor shall identify variations in energy performance due to plant operation.

Examples of operational characteristics specific to drinking water utilities include gallons of water produced, source water utilized (surface or ground water), topography, and disinfection method. Examples for wastewater utilities include processed gallons, capacity factor, biological oxygen demand (BOD) removed, secondary and tertiary treatment types, solids handling, total suspended solids (TSS), total system lift station capacity and nutrient removal. The contractor shall also identify significant local and regional differences that impose performance requirements on water and wastewater utilities. These may include varying treatment levels depending on water source (water utilities) and receiving waters (wastewater utilities), aging infrastructure, excess capacity, nutrient removal requirements, water scarcity and reuse issues. While energy use is the primary dependent variable, energy cost is the concern of operators. Energy price might impact the selection of specific processes, so price or cost will also be collected. Onsite electricity generation and biogas reuse will also need to be noted. Ultimately, the most relevant drivers shall be captured within the energy use metrics and incorporated within the comparison framework via multiple regression analysis.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by helping water utilities improve the efficiency of their use of water consumption and treatment.
- Improving the environmental and public health costs/risk of California's electricity by using less energy to provide and treat water.
- Improving the safety of California's electricity by helping provide low-cost clean water.

Proposed Outcomes:

1. The research will produce an energy performance metric and corresponding framework for making valid comparisons among plants. Any utility will be able to self-assess its energy performance compared to an industry-wide performance benchmark.

Project Status:

A contract between AwwaRF and CDH Energy Corporation has been executed and work is underway.

Energy Efficiency Projects for Water Treatment

Contract #: 500-03-025 **Project #:** 1

Contractor: American Water Works Assoc Research Foundation

Project Amount: \$550,000

Contractor Project Manager: Linda Reekie (303) 734-3423

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

Availability of clean water at a low cost is essential to California's economy and continued prosperity. California needs to treat large quantities of water to meet both municipal and waste discharge requirements that are heavily dependent on electricity. Water treatment facilities in California use 4 percent of all the electricity used in California. An objective of the PIER program is to focus on RD&D activities that help improve the energy efficiency of water for urban, industrial, and agricultural consumption, as well as efficient treatment of wastewater.

American Water Works Association Research Foundation (AwwaRF) sponsors research to help water utilities provide high-quality water, an efficient and customer-responsive organization, infrastructure reliability, and environmental leadership. This agreement is a follow up to the development of the Water and Wastewater Energy Efficiency RD&D Roadmap. The Roadmap identified high priority research projects for the water and wastewater industries. This project is the implementation phase of the RD&D Roadmap, by using the RD&D priorities identified in the document and that in turn help the PIER program and AwwaRF achieve their respective objectives. AwwaRF and the Commission Contract Manager will share responsibilities of managing this program.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity; and improving the environmental, public health, and safety of California's electricity by improving the energy efficiency of water for urban, industrial, and agricultural consumption, as well as efficient treatment of wastewater.

Proposed Outcome:

1. Acquire the results from up to \$1,660,000 of research projects that are a high priority in accordance with the Water and Wastewater Energy Efficiency-Roadmap.

Project Status:

Requests for Proposals have been posted by AwwaRF for the following two projects:

1. Water Consumption Forecasting to Improve Energy Efficiency of Pumping Operations.
2. Assessing Risks and Benefits of Water Utility Energy Management Practices.

Energy Efficient Arsenic Removal from California Drinking Waters

Contract #: 500-02-004 **Work Authorization #:** UC MR-033

Contractor: Lawrence Berkeley National Laboratory

Project Amount: \$254,000

Contractor Project Manager: Ashok Gadgil (510) 486-4651

Commission Contract Manager: Shahid Chaudhry (916) 654-4858

Status: Active

Project Description:

This project addresses the need of new technologies to meet the new and more stringent arsenic standards. This need was identified in the CEC/American Water Works Association Research Foundation (AwwaRF) roadmap under ATP, one of the eight primary research areas representing potentially high yields in terms of energy savings and economic value.

Under this project, Lawrence Berkeley National Laboratory (LBNL) will demonstrate that their newly developed process to reduce arsenic from 50 parts per billion (ppb) to 10 ppb in drinking water is:

1. Very cost effective – less than \$1 per household per year (capital and operating costs) vs. existing \$58 - \$327 per household per year (assuming water consumption of 600 gallons per household per day).
2. Very energy efficient –saves 4,000,000 kilowatt hours (kWh) of electricity per year as compared to existing arsenic removal methods (assuming a water supply for 630,000 people at 250 gallons per person per day).
3. Will potentially reduce disposal costs associated with removing arsenic from California water supplies to meet the announced impending EPA limit of 10 ppb, down from the current 50 ppb.

This project supports the PIER Program objectives of:

- Improving the environmental, public health, and safety of California's electricity by reducing arsenic from 50 ppb to 10 ppb in drinking water.
- Improving the energy efficiency of processing water for urban, industrial and agricultural consumption by saving 4,000,000 kWh of electricity per year.

Proposed Outcomes:

1. Increase the cost effectiveness of treating arsenic in potable waters – less than \$1 per household per year (capital and operating costs) vs. existing \$58 - \$327 per household per year (assuming water consumption of 600 gallons per household per day).
2. Decrease end-use consumption in specific energy sectors by increased energy efficiency – saves 4,000,000 kWh of electricity per year as compared to existing arsenic removal methods (assuming a water supply for 630,000 people at 250 gallons per person per day).
3. Will potentially reduce disposal costs associated with removing arsenic from California water supplies to meet the announced impending EPA limit of 10 ppb, down from the current 50 ppb.
4. Increase the number of new technologies that are market-ready by the end of 2005.

Project Status:

The contract is in place and the work is in progress.

Power Quality Mitigative Solutions (EPRI Program #98)

Contract #: 500-02-028 **Project #:** 21

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$71,500

Contractor Project Manager: Brian Fortenbery (856) 218-8012

Commission Contract Manager: Mike Gravely (916) 834-3127

Status: Active

Project Description:

The Power Quality Mitigation Solutions program provides the essential information and resource tools needed to help Energy Commission Staff better understand the power quality problems facing California utility customers and how new and emerging technologies are providing solutions to address these problems. Over the last few years, the Energy Commission Industrial program participated in many industry meetings and workshops where the industry end users and industry association representatives identified their priorities for future public goods research. These industry representatives identify power quality as the top or near top issue they face in doing business in California. The information and knowledge gained through the research in this program provides the Energy Commission Staff better insight into the possible solutions that are available for California end users. This program also provides information on ongoing research efforts being funded by other power quality research organizations throughout the Nation thereby ensuring that the Energy Commission learns from and does not duplicate other ongoing research efforts.

This program builds on more than 15 years of field experience to provide information tools and training programs to help diagnose and resolve power quality problems in end-use customer operations. It includes updates to EPRI's Industrial Design Guide, the authoritative tool for working with industrial end users in power quality, distribution, and economic development activities. It offers training services for managing power quality in industrial processes. It provides information to help improve the immunity of commercial and industrial equipment to power quality disturbances. It also develops information tools that focus strategic planning on power quality issues, and designing multi-energy parks. There are project areas devoted to the application of short-term energy storage devices to enhance power quality for end-use customers as well as on the energy company T&D system.

This project supports the PIER Program objective of:

- Optimize energy conservation & resource efficiency by providing guidance on methods to enhance and improve system power quality and on the efficient use of electric energy by California industrial end users.

Proposed Outcomes:

1. Forensic Analysis Guidebook. Technical Report on System Compatibility Research.
2. Industrial Design Guide Enhancements – Addition of Modules for Automotive and Food Processing Industries and Case Studies.
3. Embedded Solution for Internet and Telecommunications Industries: Testing and design evaluation assessing the uptime requirements of process equipment in industry, and identifying advanced technologies as embedded solutions. Technical Report.
4. Performance Evaluation and Application Guidebook on Low-Voltage Series Connected Sag Mitigation Device.

Actual Outcomes:

1. System Compatibility Research: *Forensic Analysis Guidebook for Recognizing Failure Modes in End-Use Equipment*. A detailed test plan has been prepared, including a TOV testing protocol and specimens have been procured. EPRI Product ID # E215303.
2. Industrial Design Guide Enhancements: Updated *Web and CD versions*. Two new modules are under development. One for Automotive systems and one for food processing. EPRI Product ID # 1008542.
3. Embedded Solutions for Electronic Power Supplies: Technical Report: *Describing the design of embedded Solutions and Results, as well as other state-of-art ride through features in Power Supply Design*. EPRI Product ID # 1008544.
4. Performance Evaluation and Application Guidebook on Low-Voltage Series Connected Sag Mitigation Device, Technical Report: *Impact of SEMI F47 on Utilities and Their Customer – Abridged Version*. Completed on December 27, 2004. EPRI Product ID # 1011327.

Project Status:

The project was completed in December 2004.

Water Consumption Forecasting to Improve Energy Efficiency of Pumping Operations

Contract #: 500-03-025 **Project #:** 3

Contractor: American Water Works Assoc Research Foundation

Subcontractors: EmA, Inc.

Project Amount: \$187,500

Match Amount: \$220,370

Contractor Project Manager: Jennifer Warner (303) 734-3422

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The objective of the project is to provide the best options for short term water consumption forecasting available to water utilities. Short term consumption forecasting (SCTF) is required for water utilities to proactively optimize pumping and treatment operations to minimize energy use, water supply and treatment costs while maintaining a reliable and high quality product for their customers. The project will provide information on various techniques, performance data, benchmarks, selection criteria, and functional requirements to assist utilities in evaluating and selecting the best forecasting techniques.

The project will examine different forecasting methods currently used at public utilities. These forecasting methods will be tested at utilities currently not forecasting water consumption and the results documented. The SCTF performance data will be analyzed for all seasons of the year to provide peak, off-peak and average day consumption data.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by minimizing the energy used for pumps at water utilities.
- Improving the environmental, public health, and safety of California's electricity; and improving the reliability, quality, and sufficiency of California's electricity by lowering demand on the electrical grid from water utilities.

Proposed Outcomes:

1. Produce a summary of STCF methodologies and tools.
2. Establish STCF benchmarks.
3. Develop functional requirements for new STCF systems.
4. Document operational and maintenance experience from electric and water utilities.

Project Status:

A Project Advisory Committee has selected EMA, Inc. to conduct the research. A contract is currently being executed between the American Water Works Association and EMA.

Zero Liquid Discharge and Volume Minimization for Inland Desalination

Contract #: 500-01-040 **Project #:** 3

Contractor: American Water Works Assoc Research Foundation

Subcontractors: Black & Veatch

Project Amount: \$250,000

Match Amount: \$416,666

Contractor Project Manager: Jennifer Warner (303) 734-3422

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The research objective is to develop a treatment process that reduces the cost and energy consumption for inland desalination with zero liquid discharge (ZLD). The technical approach involves alternating applications of reverse osmosis (RO) with precipitation processes designed to remove the least soluble salts under conditions of controlled mixing, salt seeding, chemical addition, residence time, temperature and potential of hydrogen (pH). After removal of salts that limited recovery in the primary RO, brine is treated in a secondary RO for further product water recovery and brine volume reduction.

At least five water sources from five utilities will be tested, and a complete ZLD treatment process will be developed for each of the water sources. Treatment costs and energy consumption will be estimated for each system.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by helping water utilities improve the efficiency of their use of water consumption and treatment.
- Improving the environmental and public health costs/risk of California's electricity by using less energy to provide and treat water.
- Improving the safety of California's electricity by helping provide low-cost clean water.

Proposed Outcome:

1. Advancement and development of zero liquid discharge technologies that will include volume minimization processes that are less energy intensive for desalination of impaired water bodies in inland regions.

Project Status:

American Water Works Association Research Foundation executed a contract with Black & Veatch in September, 2004 and work is underway.

IAW Active Projects from Previous Years

Decreasing Electric Demand in California Oilfield Operations by Reducing Excess Water Production

Contract #: 500-02-015

Contractor: Petroleum Technology Transfer Council

Contract Amount: \$300,000

Contractor Project Manager: Iraj Ershaghi (213) 740-0321

Commission Contract Manager: Tony Wong (916) 654-4015

Status: Active

Project Description:

The goal of this project is to identify applicable processes and demonstrate that these processes can reduce the water associated with oil production by half. Currently California oil and gas producers produce 2.1 billion barrels of associated water for 271 million barrels of oil production per year (water:oil ratios of almost .8:1).

This project will develop analysis for oilfield producers to select technologies for their particular geologic and wellbore conditions and demonstrate corrective measures to reduce water production and the associated electric consumption, in leading to better economics for the oilfield operations.

The contractor will develop remedial action templates that incorporate operational processes and optimum management techniques for perforation mapping and the use of chemicals and cements. In addition, the project will include field demonstration sites with different geological and completion templates.

If successful, the results of this project will encourage wider acceptance of water control technologies by the oilfield operators. It will reduce statewide electrical demand and consumption.

This project supports the PIER Program objectives of:

- Improve the environment, public health and safety by identifying applicable processes and demonstrating that these processes can reduce the water associated with oil production by half.
- Improve energy/cost value by reducing water production and the associated electric consumption, in leading to better economics for the oilfield operations.

Proposed Outcomes:

1. Identify applicable processes and demonstrate that these processes can reduce the water associated with oil production by half.
2. Develop an analytical tool for oilfield producers to select technologies for their particular geologic and wellbore conditions.
3. Demonstrate corrective measures to reduce water production and the associated electric consumption, in leading to better economics for the oilfield operations.

Project Status:

This project began on February 24, 2003. The contractor has obtained and analyzed well logs, surveys, wellbore diagrams, etc. from various oilfield producers. The contractor has held two conference presentations about the interim results of the study.

The contractor has developed remedial action templates that incorporate operational processes and optimum management techniques for perforation mapping and the use of chemicals and cements. The contractor has completed testing the template against a number of oilfields in the data base of California waterflood.

The contractor will select oilfield operators to participate in the field demonstration of corrective measures to reduce water production.

Demand Response Database

Contract #: 500-02-014 **Work Authorization #:** E2I-WA-105

Contractor: Electricity Innovation Institute

Project Amount: \$620,100

Contractor Project Manager: Ellen Petrill (650) 855-8939

Commission Contract Manager: Laurie ten Hope (916) 654-5045

Status: Active

Project Description:

For the State to meet the identified need for building an infrastructure for demand response programs, it is critical to understand all the elements of how end-use customers select and respond to individual demand response programs. Encouraging end-use customers to modify their electrical load based on the demand needs of the electrical grid has the potential of providing significant improvements in electric system reliability and stability. Development of a consistent, comprehensive, time-stamped database of end-use customer participation in demand response programs is crucial in understanding customer actions and achieving the State's goals in Demand Response.

The comprehensive, consistent, time-marked and representative database on end-use customer critical peak pricing (CPP), demand bidding program (DBP) and other demand response programs has been developed and is currently being used to store data from a selected number of the largest CPP and DBP participants. End-use customer data from other PIER funded demand response projects has also been added to the database so additional analysis and research can be completed.

In 2004, the data base was modified to include data collected from sub metered end-use sites in Northern and Southern California. Detailed analysis of these sub metered sites provides researchers unique insight into how these end-users were able to achieve their individual demand response goals. Combining this sub metered data with other data in the Demand Response Database provides PIER researchers with the unique data tools necessary to better understand the key elements of successful demand response programs and tariffs.

The PIER Demand Response Database provides PIER researchers and other State organizations interested in the successful and timely implementation of future demand response programs and tariffs unique tools and insight into how end-use customers can modify their electrical loads in response to the critical short term needs of the electrical grid system. By analyzing this integrated data from a variety of diverse demand response programs, researchers can:

- Identify successful end-use customer demand reduction strategies that will allow a wider acceptance and participation of future California demand response programs and tariffs.
- Develop load reduction potential assessments of these demand response programs from different customer classes to provide more accurate assessments of its impact on the California electrical grid.
- Identify areas where new research will provide the opportunity to increase demand response program participation and/or impact.

This project supports the PIER Program objectives of:

- Improving the reliability/quantity of California's electricity by encouraging end-use customers to participate in demand response programs and thereby reduce to overall demand on the electrical grid during times of peak demand.
- Improving the energy cost/value of California's electricity by providing end-use customers new energy pricing options that permit them to meet their electrical needs and lower total energy costs.

Proposed Outcomes:

1. Produce a data collection product functional description report.
2. Produce data collection and storage system documentation, instructions and operational manuals.
3. Collect and store data base elements throughout the time of this project.
4. Produce a final report on the results and lessons learned during the project.

Project Status:

Data definition, collection and storage will continue into 2005.

Demonstration of Energy Efficient Ultra Low NO_x Burner (ULNB) Control Technology

Contract #: 500-02-004 **Work Authorization #:** UC MR-008

Contractor: Alzeta Corporation

Project Amount: \$357,600

Match Amount: \$100,290

Contractor Project Manager: Neil McDougald (408) 727-8282

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

The project will develop a control strategy that will use 25% less electrical energy in an ultra low NO_x (nitrogen oxide) burner (ULNB) operation and demonstrate the technology by converting two industrial boilers to employ the new strategy. When commercialized, this technology will reduce the electric consumption of industrial boiler operators in California. The technology will allow boiler and process heater end users to reduce both their capital and their operating costs for energy while meeting newly mandated air pollution requirements.

This technology potentially can be used by the 1600 boilers in Central Valley, most operating during summer peak. When commercialized, this technology could potentially reduce peak demand by 30 MW and electricity consumption by 65,300 MWh.

This project supports the PIER Program objective of:

- Optimize energy conservation & resource efficiency by developing a control strategy that will use 25% less electrical energy in an ULNB operation.

Proposed Outcome:

1. Use 25% less electrical energy in an ULNB operation and demonstrate the technology by converting two industrial boilers to employ the new strategy.

Project Status:

The project kickoff meeting was held in December 2003 and the conversion of the first boiler to the new technology has been completed. Small field demonstration site installation and commissioning were completed, and monitoring began in early 2004. The first critical project review was conducted on July 8, 2004. Three potential sites for the large-scale boiler installation were identified and laboratory testing of the large scale boiler control system also began. The large boiler control system installation was also completed at a dairy plant in central California. Monitoring of this system is to begin shortly.

The technology developed and demonstrated under this contract seems to be meeting its intended performance targets. Overall the project progressed very satisfactorily during 2004 and is close to completion.

Development and Demonstration of Digital System for Control and Monitoring of Oxygen Transfer Efficiency Measurements

Contract #: 500-03-001

Contractor: Southern California Edison

Subcontractors: UCLA

Contract Amount: \$964,073

Match Amount: \$944,751

Contractor Project Manager: Lory Larson (626) 633-7161

Commission Contract Manager: Shahid Chaudhry (916) 654-4858

Status: Active

Project Description:

This project involves the development and demonstration of a new portable, lightweight, digital automated system for the accurate monitoring and control of the oxygen transfer efficiency (OTE) measurements in the wastewater treatment industry. This new small-size and light-weight equipment will encourage the activated sludge wastewater treatment facilities to conduct OTE measurements in-house on a regular basis with minimal technical expertise. This, in return, will result in reduction in energy consumption for aeration and decrease the operating costs of wastewater treatment plants in California.

The project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by developing a technology with a near-term market application that could substantially reduce cost and manpower for routine monitoring of wastewater aeration performance.

Proposed Outcome:

1. A new and reliable aeration monitoring equipment that will be able to conduct in-house OTE measurements in activated sludge process on a regular basis with minimal technical expertise. The successful completion of this project will lead to significant reduction in energy for aeration and decrease the operating costs for wastewater treatment plants in California.

Project Status:

Work will begin February 2005.

Development of an Integrated Benchmarking and Energy and Water Management Tool for the Wine Industry

Contract #: 500-02-004 **Work Authorization #:** UC MR-012

Contractor: Lawrence Berkeley National Laboratory

Project Amount: \$202,000

Contractor Project Manager: Ernst Worrell (510) 486-6794

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

The project involves a detailed analysis of energy and water use in a winery operation, the assessment of integration possibilities between different wine making processes, and the development of an easy to use energy and water use model. The project will develop an integrated energy and water efficiency measurement called the Energy Efficiency Index (EEI). This index will be validated by field tests at several wineries.

Such an index would be equivalent to “miles per gallon” for an automobile. It would allow the industry to easily assess their current level of energy efficiency and also assess the benefits of implementing energy efficiency projects.

In 2001 the wine industry in California consumed 406 million kilowatt hours (kWh) of electricity and 23 million therms of thermal energy. The peak load is estimated at 144 MW. Based on audits at various wineries, using the index in determining the impact of energy conservation efforts should result in a 20% potential savings, resulting in a reduction of 75 million kWh of electricity and approximately \$8 million to the wineries.

This project support the PIER Program objective of:

- Optimize energy conservation & resource efficiency by developing an integrated energy and water efficiency measurement called the Energy Efficiency Index.

Proposed Outcomes:

1. Develop an integrated energy and water efficiency measurement called the Energy Efficiency Index.
2. Seek adoption of this tool by utilities in determining and granting energy efficiency rebates.

Project Status:

The wine making process has been modeled by using data from an existing winery. The data and model validated in Jan 04 at a meeting with the winery facilities and energy/environmental management staff. The Integrated Benchmarking Tool is in the final stages of development. The project underwent a principal investigator (PI) change in August 2004. A presentation of the findings will be made at the NWFPFA Expo in Portland, Oregon in January 2005. The project is progressing well but about six months behind schedule.

At present a major California utility is exploring the possibility of integrating this tool in its energy efficiency rebate program.

Development of an Ultracapacitor-Based Stabilizing System for Generators in Industrial and Commercial Facilities

Contract #: 500-01-025 **Work Authorization #:** E2I-WA-004

Contractor: Electricity Innovation Institute

Project Amount: \$146,408

Match Amount: \$146,407

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Active

Project Description:

In 2004 the project team developed the functional specifications for the dynamic stabilizer, including its voltage rating, power requirements, energy storage needs, response characteristics, modes of operation, packaging requirements, thermal design, etc. The project team identified the prototype hardware requirements based on the functional specifications. This includes identifying vendors of off-the-shelf components that can be used in the system, as well as any special hardware development needs or modifications to off-the-shelf equipment that are required.

The design team developed a detailed system design that includes the functional specifications, detailed system diagrams, and parts lists/vendor suppliers. The team also developed a prototype design for the dynamic stabilizer identifying which components are commercially available and which components require additional development. Then computer simulations and limited component testing was completed on the key elements of the design.

In 2005, the project team will complete all the elements of the detailed design and publish a technical report with the results of all the completed simulations and tests. Based on the successful completion of this effort, additional field analysis will be done to determine the most appropriate field trial demonstration for the dynamic stabilizer. Any actual future field demonstrations will be completed under a separate contract and are not funded through this effort.

In the long term, development of this technology will allow the end-users with critical electrical loads to use the smaller sized generators resulting in low capital and operating costs, reduce emissions and fuel use, and at the same time make the grid immune from sudden starts of back-up generation.

This project supports the PIER program objectives of:

- Improving the reliability/quality of California's electricity by acquiring knowledge and developing procedures to solve power quality problems caused by mismatched field equipment and process disruptions associated with equipment failures.
- Improving the energy cost/value of California's electricity by reducing inefficiency associated with oversized field generation equipment.

Proposed Outcomes:

1. Develop the functional specifications for the dynamic stabilizer.
2. Assess the current state of commercial off the shelf components to identify which components are appropriate for the field demonstration of the dynamic stabilizer.
3. Produce final report detailing the results and lessons learned during the project.

Project Status:

The project is expected to be completed by May 2005.

Dynamic Characterization of Process Power Quality

Contract #: 500-01-025 **Work Authorization #:** E2I-WA-003

Contractor: Electricity Innovation Institute

Project Amount: \$20,300

Match Amount: \$20,300

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Active

Project Description:

The purpose of this project is to analyze the power quality impacts and short- and long-term solutions for the California food processing industry using the Del Monte Foods Company plant in Modesto as a benchmark. This effort is intended to lead to a comprehensive power quality supply chain management procedure for the California food processing industry. As part of this supply-chain management procedure, a power quality immunity specification will be developed for process automation tools and components in cooperation with representatives of the food processing industry, Electric Power Research Institute (EPRI), California Energy Commission (CEC), equipment suppliers, and standards organizations. In addition, this work will lead to a recommended practice document for addressing power quality issues in food processing industry for existing plant equipment.

The project involves the following tasks:

- Assess the impacts of power quality disturbances on process automation equipment for the Del Monte Foods plant in Modesto. The project team will complete a baseline assessment for the plant to evaluate the process control tool, equipment requirement and its interaction with the plant electrical environment.
- Develop target ranges for process equipment immunity based on controlled testing. The project team will evaluate the component level sensitivity for the Del Monte Foods plant based on the baseline characterization.
- Develop a final report and technology transfer activities. The project team will develop a comprehensive report specifically for the Modesto plant to describe the short-term and long-term solutions for minimizing power quality related process upsets. A separate report will be developed for distribution to the California food processing industry to describe power quality related impacts and possible short- and long-term solutions.

This project supports the PIER program objectives of:

- Improving the reliability/quality of California's electricity by developing knowledge and procedures to solve power quality problems that cause equipment failures and process disruptions.
- Improving the energy cost/value of California's electricity by reducing process inefficiency associated with power quality disturbances.

Proposed Outcomes:

1. EPRI will complete the field assessment of at least two sites in the food processing industry to better understand the ability of the food processing industry to apply new technology to increase automation and improve efficiency.
2. Based on the results of the field assessments, EPRI will demonstrate to the food processing industry the ability to integrate new technology into their processing line that will increase automation, increase productivity and reduce overall operating costs.

3. Presentation to the food processing industry on the results and lessons learned during this project.
4. Final report on the results and lessons learned during the project.

Actual Outcomes:

1. EPRI completed the assessment of two sites in the food processing industry and developed site level technical reports that demonstrate the ability to integrate new technology into plant processing lines that will increase automation, increase productivity and reduce overall operating costs.
2. EPRI provided the food processing industry two technology transfer presentations on the lessons learned from this project.
3. Final report on the results and lessons learned during project was completed.
4. Several Major Food Processing Industry companies have implemented the recommendations made in the final report and have modified their plant processes to capture the costs savings.
5. Based on the success of this project major food processors in other states have conducted workshops to learn about and implement the technical procedures and procure the equipment recommended in the final report. Currently efforts are afoot within the food processing industry to develop “standards” for procedures and equipment.

Project Status:

The project is complete and the final report will be published and available on the Commission’s website April 2005.

Electrodialysis Systems for Tartrate Stabilization of Wine

Contract #: 500-02-009

Contractor: Winesecrets, Inc.

Subcontractors: Ameridia : Vinnovation, Inc.

Contract Amount: \$309,757

Match Amount: \$926,229

Contractor Project Manager: Eric Dahlberg (707) 738-5083

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Active

Project Description:

The purpose of this project is to demonstrate a new energy efficient tartrate stabilization process for wine industry using electrodialysis. This new technology uses less than 20 percent of the electrical energy used in the conventional cold stabilization process. Adoption of this process will enable the California wine industry to improve wine marketability and quality while reducing bottle price.

Cold storage is the method used predominately in the United States for tartrate stabilization in wine processing. The total electrical energy consumption for cold stabilization is estimated at about 70kWh per thousand gallons of wine. Electrodialysis uses about 12 kilowatt hours (kWh) per thousand gallons of wine, which makes it less energy intensive than cold stabilization. It may also produce better quality wines. Due to concern regarding the deployment of this new technology on color, taste or smell of its product, the wine industry in California has not installed this promising technology.

Under this contract, a 600 gallons-per-hour mobile electro-dialysis demonstration unit was built and tested. During 2003 and 2004 the mobile unit was taken to four leading vintners in California and a fraction of their wine production was stabilized using the new technology. The energy savings and other wine characteristics were tested and documented. Additional on-site demonstrations were conducted at the wine production sites of small as well as large wine makers. The success of the new process was confirmed when two major wineries ordered repeat demonstrations for larger volumes and used the technology for a variety of wines. One major winery is exploring ordering a large unit so that it can have a permanent installation at its own site. Demonstration of new electro-dialysis and membrane technology by the PIER program has convinced the industry leaders about its energy savings potential and ability to maintain product quality.

The demonstration has also convinced the Alcohol and Tobacco Tax and Trade Bureau (TTB) to approve this technology as an acceptable technology for wine processing, and this acceptance has been published in November 2004 Federal Register. This step by the federal government has removed a major barrier to acceptance of this technology by the wine industry.

Two articles have been published in the industry journals leading to increased industry interest and participation. The technology is now being actively promoted at industry exposition and conferences.

This project contributes to the PIER program objective of:

- Improving energy cost/value by gaining the acceptance of the wine industry for a new energy efficient tartrate stabilization process.

Proposed Outcomes:

1. Demonstrate of mobile electro-dialysis systems in three California wineries.
2. Report on the performance and electricity savings.
3. Install one stationary electro-dialysis system in California.
4. Gain acceptance of this new technology by the Bureau of Alcohol, Tobacco & Firearms (BATF).
5. Give a technology transfer workshop.

Project Status:

Wineries in Napa, Sonoma and Central valley have began using this technology on a job shop basis, where the mobile units treats these wine on contact basis, thus reducing and/or eliminating the need for using electricity to remove tartrate.

- The mobile demonstration electro-dialysis unit has been assembled and put into service.
- Six demonstrations at major wineries completed and substantial energy savings documented.
- Review completed at two wineries for a large scale, stationary electro-dialysis unit installation as part of winery's production process.
- Two articles published in the industry journals leading to increased industry interest and participation: "New Technology Reduces the Cost to Stabilize Wine," *Wine Business Monthly*, August 2003, and "New Choice for Tartaric Stability," *Practical Winery & Vineyard*, January/February 2004.
- Using the data from demonstrations under this contract, Alcohol and Tobacco Tax and Trade Bureau (TTB) of the federal government approved this technology as an acceptable technology for wine processing. Formal acceptance has been published in November 19th 2004 Federal Register.
- Technology was promoted at two different wine industry expositions at the vendor's booth and also at industry energy use workshops on two occasions.

Energy Efficient Agricultural Technologies

Contract #: 400-99-005

Contractor: The Regents of the University of California, Davis

Contract Amount: \$1,793,000

Contractor Project Manager: James Thompson (530) 752-6768

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Active

Project Description:

The purpose of this contract is to advance the development of energy efficient agricultural technologies.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of emerging electro-technology applications in agriculture.
- Improving the environmental and public health costs/risks of California's electricity by replacing toxic chemicals used in agribusiness with cleaner electro-technologies.

Proposed Outcome:

Advance the development of energy efficient agricultural technologies by funding the following nine projects:

1. Ozone as a Soil Fumigant.
2. Ozone as an Aqueous Disinfectant.
3. Ozone as a Gaseous Fumigant.
4. Evaluate Changes in the Physical and Chemical Properties of Soils as a Result of Ozonation.
5. Dairy Waste Management.
6. Energy Efficiency through Soil Compaction and Moisture Profile Sensor Development.
7. Irrigation Scheduling.
8. Conduct market study to establish industry benchmark for refrigerated warehouses.
9. Industrial refrigeration RD&D program.

Project Status:

The market study benchmark project (project 8) and the industrial refrigeration RD&D program (project 9) are active. All other work authorizations have been completed.

1. The soil ozone project has completed the field research phase and issued a final report. The technology did not show consistent effectiveness at controlling soil borne diseases and pests. No further research is anticipated.
2. The project using ozone to control fungi in the cold water wash process at packing sheds has finalized the research phase. The researchers from the US Department of Agriculture continue to disseminate their project results to companies considering the upgrade of their systems to incorporate this technology.
3. The project using ozone to control invertebrate pests has proven the need to increase ozone application levels as well as to mix ozone with carbon dioxide (CO₂) gas to further improve control. USDA researchers will continue to advance this technology with other funding sources.
4. This project provided scientific support to the Soil Ozonation project to study the potential impact of ozone gas on soil conditions. There was a positive response in

- microbial activity with potential to enhance soil quality. The project completed the research.
5. The dairy manure waste management project has had delays due to uncooperative farms not committed to following the research methods, thus rendering field data unsuitable. UC Davis researchers have acquired additional funds from the Air Resources Board to continue the development of best management practice recommendations to the dairy industry.
 6. The Soil Compaction and Moisture Profile Sensor Development project completed the research phase by building second generation prototype tools. During the 2004 growing season, the project completed further field tests to finalize data gathering and evaluation. The project received a patent for the development of the soil compaction tool.
 7. The deficit irrigation project has concluded the field research activities. Research results were inconclusive regarding the accuracy of the data provided by the trunk moisture measurement device. Further research is needed to calibrate the tool. The project researcher has communicated with the equipment manufacturer providing recommendations for further product improvements.
 8. The market study to establish industry benchmark for refrigerated warehouses project has developed the survey instrument, will administer the survey during the April to May 2005 period, and conduct in-depth interviews in the summer with a completion date of December 2005.
 9. The industrial refrigeration RD&D program will release a request for proposals during the 2005 summer. Two or three projects will be selected for funding.

Food Processing Research Collaboration Project

Contract #: 500-02-029 **Project #:** 5

Contractor: Gas Technology Institute

Project Amount: \$40,000

Contractor Project Manager: Steve Sikirica (847) 768-0859

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

This project is targeted at identifying the highest-priority needs, developing innovative technical solutions, and initiating targeted R&D activities. This research will be coordinated directly with the food processing industry and will integrate the information and prioritized needs identified from the industry participants.

Utilizing existing and targeted analysis, this project will:

1. Identify five key food segments and assess current energy utilization at related facilities.
2. Identify process, hardware, and needs.
3. Summarize the related current R&D and gas-fired technology for the identified food segments.
4. Develop a new gas-fired product concept or best available technology report for each food segment.
5. Select and complete exploratory research on one concept.
6. Complete product development recommendations for the selected concept.

This project supports the PIER Program objective of:

- Improving the energy value/cost of California's electricity by developing new technologies for the food processing industries in California.

Proposed Outcomes:

1. Perform a technical assessment of five key food segment processes and equipment. Investigate best practices and write best practices information summary.
2. Perform a concept prioritization and evaluation.
3. Develop a framework and plan for progressing towards product development of the most promising food processing concepts.

Project Status:

- a. Phase I is completed and the summary report was received from the GTI. Initial product development analysis has started.
- b. The topical report included appendices on the actual interviews conducted, production process descriptions, energy use summaries, technology trees, and technology descriptions by industry. Report Title: *Benefits of GRI RD&D Results That Have Been Placed in Commercial Use in 1998 Through 2002*. Report Publication #: GRI-03/0106. Available at:
⇒ <http://www.gastechnology.org/webroot/downloads/en/4ReportsPubs/TechReports/040061.pdf>

The project is within the budget and is expected to be completed by June 2005.

High-Performance High-Tech Buildings/Laboratories, Cleanrooms, and Data Centers Project

Contract #: 500-02-004 **Work Authorization #:** UC MR-016

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Subcontractors: EPRI PEAC Corporation : Ecos consulting : Rumsey Engineers, Inc. : EYP Mission Critical Facilities, Inc.

Project Amount: \$3,280,000

Contractor Project Manager: William Tschudi (510) 495-2417

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The purpose of this project is to continue previous PIER research and development contracts for energy efficiency technologies for laboratories, cleanrooms and data centers.

I. Laboratories and Cleanrooms

This task will focus on the following subtasks:

- **Benchmarking High-tech Buildings and Developing Best Practices** – Benchmarks from an additional six cleanrooms or labs will be obtained. Case studies from the benchmarking will be used to identify best practices and recommended efficiency measures. LBNL will also characterize standby diesel generator energy use.
- **Energy Efficient Filtration** – LBNL will work with the Industrial Technology Research institute and the Air Movement and Control Association to develop standard test procedures to determine the energy efficiency for fan filter units. These units are the primary drivers of recirculating air in these facilities and can use up to 35 percent of the HVAC energy use.
- **Cleanroom Heating, Ventilating, and Air Conditioning** – LBNL will develop demand control filtration concepts and methodology for implementation in labs and cleanrooms. This work will include developing energy efficiency opportunities for mini-environments within cleanrooms that are critical to the semiconductor industry.
- **Berkeley Fume Hood Development** – LBNL will conduct side-by-side testing with a standard hood to demonstrate energy efficiency. There will also be demonstrations at three industrial facilities. This task is contingent upon LBNL obtaining a variance from Cal/OSHA standards. If the variance is not obtained, the funds allocated to this task will be reallocated to demonstrations or other tasks.

II. Datacenters

This task will focus on the following subtasks:

- **Benchmarking Datacenters and Developing Best Practices** – An additional 6-10 datacenters will be benchmarked, four of which will be in Southern California. In addition to the benchmarks, LBNL will obtain standby generator energy use at the facilities. The benchmarking data will be used to develop a self-benchmarking protocol and best practices for industry use.
- **Datacenter Building Systems Efficiency** – LBNL will research efficiency of uninterrupted power supply (UPS) systems including part load rating and optimal redundancy strategies.
- **Datacenter Building/IT Interface Issues** – LBNL will interact with other research organizations to keep California companies abreast of energy efficient products.

- **Datacenter IT Equipment Issues** – LBNL will assess the efficiency of power supplies in datacenter servers and other IT equipment.

III. Industrial Demonstrations

This project will include demonstrations for any of the deliverables for laboratories, cleanrooms or datacenters outlined above. These demonstrations will be conducted with industry partners or other research organizations.

This project supports the PIER Program objectives of:

- Improving energy cost/value by assessing the energy efficiency of laboratories, cleanrooms and datacenters.
- Improving electricity reliability, quality and sufficiency by providing research for the development of energy efficiency technologies for laboratories, cleanrooms and data centers.

Proposed Outcomes:

1. Six benchmarks for laboratories and cleanrooms and case study reports on LBNL website.
2. Draft standard test procedure for fan-filter units available on LBNL website (subject to Commission and industry approval).
3. Demand controlled filtration case study report on LBNL website and as an appendix to the final report.
4. A case study report comparing use of mini-environments with current practice on LBNL website and as an appendix to the final report. Mini-environment performance (efficiency) reported as well as efficiency improvement opportunities.
5. Variance from Cal OSHA for demonstrating Berkeley Fume Hood at three industrial sites and side-by-side testing results.
6. Case study reports and summary benchmarking results for 6-10 datacenters with at least four in southern California.
7. Data Center Self-benchmarking protocol on LBNL website and as an appendix in final report.
8. Report on research concerning performance of available UPS technologies.
9. Report on research into available cabinet and rack systems and their relative energy efficiencies.
10. Report on existing power supply performance.
11. Reports for each demonstration project available on LBNL website.

Project Status:

- LBNL has held two Project Advisory Committee (PAC) meetings for both laboratories and cleanrooms and datacenters.
- Benchmarking for datacenters, labs and cleanrooms are underway.
- LBNL has completed a draft test procedure for fan filter units.
- LBNL has completed a pilot study for demand control filtration.
- LBNL has completed both static tests and “Human as Mannequin” tests on the Berkeley Fume Hood to the satisfaction of CalOSHA staff and has scheduled a hearing with CalOSHA for a variance for demonstrations at industrial sites and to perform side-by-side testing.
- LBNL has identified four potential demonstration projects.

Improved Heat Exchanger Surfaces with Reduced Fouling

Contract #: 500-02-004 **Work Authorization #:** UC MR-014

Contractor: Pennsylvania State University

Project Amount: \$210,500

Contractor Project Manager: Virendra M. Puri (814) 865-3559

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

This project will conduct laboratory experiments to evaluate the effectiveness of nickel-phosphor-Poly-tetrafluorethylene (Ni-P-PTFE) coating on heat exchanger surfaces to reduce fouling during the heating of dairy products, and fruit and vegetable juices.

Heating of liquids is a common operation in food industry, e.g. pasteurization of liquid milk and concentration of fruit and vegetable juices. When liquids are heated there is a formation of fouling layers in the food processing equipment. Fouling increases energy used for heating and increases electrical energy used in the process. Fouling further increases both thermal and electrical energy consumption by increasing frequency and duration of cleaning operations. This project would test a new coating that eliminates or reduces fouling, thus improving the energy efficiency of the heating processes.

California has over 100 plants processing over 35 billion pounds of milk annually and accounts for over 10% of the milk production in US. California is also a major producer of fruit and tomato juices. If the technology is fully implemented for milk and juice processing, these operations would potentially save 15,000 megawatt hours (MWh) of electricity and 6,300 million therms of natural gas in California. It is estimated that a typical pasteurized liquid milk plant processing 120,000 gal/day using this coating will save 150,000 kilowatt hours (kWh) of electricity and 63,000 therms of natural gas based on 50% reduction in fouling related energy consumption.

This project support the PIER Program objective of:

- Optimize energy conservation & resource efficiency by conducting experiments to evaluate the energy efficiency gained by using Ni-P-PTFE coatings on heat exchanger surfaces at food processing plants.

Proposed Outcome:

1. Evaluate the effectiveness of nickel-phosphor-Poly-tetrafluorethylene (Ni-P-PTFE) coating on heat exchanger surfaces to reduce fouling during the heating of dairy products, and fruit and vegetable juices.

Project Status:

The project staff is currently finalizing the terms and conditions of the contract before commencing the work.

Infrared Drying of Rice to Improve Energy Efficiency and Disinfestation

Contract #: 500-02-004 **Work Authorization #:** UC MR-010

Contractor: University of California, Davis

Project Amount: \$211,437

Contractor Project Manager: Zhongli Pan (530) 750-2124

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

Develop and test a large scale infrared rice dryer. Establish optimum operating parameters for and effectiveness of infrared treatment on disinfestations and microbial counts. The technology will reduce the use of large volumes of hot air for drying grain. Moving air requires large fans that use vast amount electricity. The infrared process heats the grain faster and more effectively with minimal use of natural gas.

This project supports the PIER Program objectives of:

- Optimize energy conservation & resource efficiency by developing and testing a large scale infrared rice dryer.
- Improve Environmental and Public Health risk/costs by establishing optimum operating parameters for and effectiveness of infrared treatment on disinfestations and microbial counts.

Proposed Outcomes:

1. Reduce peak demand by 84 MW and electrical consumption by 128 million kWh per year by developing and optimizing the infrared dryer.
2. Reduce natural gas consumption by 11 million therms per year.

Project Status:

The project kick-off meeting was held in December 2003. The test drying of rice and onions with infrared dryers is being conducted. The rice drying tests with Catalytic flameless gas-fired infrared dryers (CFG IR) indicated a significant reduction in drying time and improvement in the head rice yield. Therefore, this is expected to be a viable technology for rice drying. The prototype selective wavelength infrared dryer (PSW IR) tests with rice were also favorable, but the test dryer requires modifications for continued testing. The onion drying tests with CFG IR dryer produced shorter drying times and lower drying temperatures compared to conventional hot air drying. The PSW IR dryer did not produce favorable results in onion drying.

Task 5 of the project, that involved the validation of experimental results with large scale CFG IR dryer, was downscaled due to the potential for a full-scale demonstration project. On December 6th, 2004 the President of Catalytic Industrial Group (manufacturer of CFG IR dryer) visited the Gilroy Foods and USDA laboratory in Albany to evaluate the potential for this technology.

If a suitable cost-sharing partner and interested vendor are found, a full scale demonstration will follow.

Metropolitan Water District of Southern California

Contract #: 400-00-013

Contractor: Metropolitan Water District of Southern California

Subcontractors: West Basin Municipal Water District : San Diego County Water Authority : Orange County Water District : Alameda County Water District : Santa Clara Valley Water District : Sonoma County Water Agency : University of California, Riverside : University of California, Los Angeles

Contract Amount: \$2,000,000

Match Amount: \$3,013,688

Contractor Project Manager: Christopher Gabelich (909) 392-5113

Commission Contract Manager: Shahid Chaudhry (916) 654-4858

Status: Active

Project Description:

The purpose of this contract is to co-fund the full-scale demonstration and refinement of newly developed electro-technologies for producing potable and non-potable water. These technologies remove salinity and disinfect various source waters (i.e., Colorado River water, brackish ground water, municipal wastewater, and agricultural drainage water). The Energy Commission partially funded development of these technologies through PIER Transition Funding (\$410,000- 1997) and PIER I Funding (\$1,200,000- 1998).

Benefits to California:

1. Electric utility ratepayers would benefit from reduced energy used to transport and produce high quality potable water in the region. Total energy savings are estimated to be 12,000 gigawatt-hours (GWh) over 20 years.
2. Additional development of local water supplies could partially offset the need to import water from outside the region, reducing pumping costs and energy usage. The results generated from this study may result in 7,000,000 acre-feet of additional potable water for California.
3. Savings from developing local supplies are estimated to be in excess of \$140 million.
4. Savings from avoiding salinity damages to commercial, industrial, and residential property are estimated to be in excess of \$500 million.

This project supports the PIER Program objectives of:

- Improving electricity reliability/quality/sufficiency of California's electrical system by providing energy savings of approximately 12 GWh in avoided water transport and production of high-quality potable water.
- Improving the energy cost/value of California's electricity by producing an additional 7,000,000 acre feet of water with savings of approximately \$140,000,000 from developing local water supplies instead of importing water from outside the region, reducing pumping costs and energy usage.
- Improving the environment, public health and safety by avoiding approximately \$500,000,000 of salinity damages.

Proposed Outcomes:

1. Demonstrate new and large-scale electro-technologies that reduce the energy requirement and cost of producing potable water.
2. Partner with industry to ensure the commercial implementation of newly developed treatment technologies.

3. Reduce the need for energy-intensive water imports through technologies allowing development of local, non-traditional water supplies.

Project Status:

The original term of this contract was from January 15, 2001 to July 31, 2003. A no-cost time-extension has extended the term of this contract to March 31, 2005. Also, the work scopes under subtasks 2.2.3 and 2.3.2 have been changed. New work under subtask 2.2.2 will expand its scope to include the rejection pattern of wastewater derived micro-pollutants in high-pressure membrane applications. Under subtask 2.3.2, the subcontractor will develop a knowledge base of existing low-pressure membrane filtration (Reverse Osmosis and Nano-Filtration) plants worldwide that treat five types of water and wastewater.

The start of this project was delayed by six months from the original proposed start date due to the legal and contractual issues between the Commission and the West Basin Municipal Water District. Execution of subcontracts agreements proceeded slower than initially anticipated due to contract language issues between the contractor and subcontractors. However, by the end of November, 88% of the project work was completed, and the project will be completed by the end date of March 31, 2005.

Oil-Field Flare Gases Electricity Project (Offgases)

Contract #: 500-02-016

Contractor: California Oil Producer's Electricity Cooperative

Subcontractors: FlexEnergy, Inc. : Mesa Verde Associates

Contract Amount: \$1,000,000

Match Amount: \$1,043,325

Contractor Project Manager: Robert Fickes (562) 495-9354

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The purpose of this project is to convert shut-in gases at oil well sites into a usable energy source for distributed generation. Shut-in gas is a waste gas that cannot be marketed because it does not meet pipeline specifications, or there is no pipeline in close proximity to the oil well. The shut-in gases also do not meet fuel specifications for microturbines or other distributed generation options because of impurities, liquid content or heat content. Shut-in gas is typically flared or reinjected back into the oil well.

The project will select four oil wells for demonstrations that will address a wide range of technical difficulties for implementing distributed generation using shut-in gas. Each demonstration will utilize existing technologies to condition the shut-in gas to meet fuel specifications for distributed generation. The four oil wells will be selected for heat content to cover the entire range of shut-in gas. This range is as follows:

- High British thermal unit (BTU) content (above 1500 BTU/standard cubic feet (scf)).
- Medium BTU content (300-1400 BTU/scf).
- Low BTU content (100-200 BTU/scf).
- The fourth site will have the worst possible gas and be the least likely for successful implementation of distributed generation. The gas will be significantly below pipeline specification and have a high amount of noncombustible and corrosive components.

The demonstrations will show that it is possible to implement distributed generation at varying heat content and provide a cook-book approach to gas conditioning problems for oil well operators.

This project supports the PIER Program objective of:

- Improving electricity reliability and quality, and improving energy cost/value by converting shut-in gases at oil well sites into a usable energy source for distributed generation.

Proposed Outcome:

1. Technologies that can effectively use the off-gases from the California oil wells. These technologies can potentially provide 400 MW of distributed generation, and also allow for increased production of oil once the off-gases are removed as a barrier.

Project Status:

- High BTU Demonstration: Site has been selected and a contract with owner executed. Installation and testing of the site is underway.

- Medium BTU Demonstration: Installation and testing is completed, monitoring and maintenance is underway.
- Low BTU Demonstration: Negotiations for possible site underway.
- Harsh Gas Demonstration: Site has been selected and a contract with owner executed. Installation and testing of the site is underway.

PIER Agriculture Energy End Use Efficiency

Contract #: 400-99-014

Contractor: California Polytechnic State University Foundation

Contract Amount: \$1,500,000

Contractor Project Manager: Charles Burt (805) 756-2379

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Active

Project Description:

The purpose of this contract is to improve the energy efficiency in the transportation, delivery, and utilization of agricultural water provided by irrigation districts. Until the infrastructure needs of the irrigation districts are adequately addressed, most sophisticated on-farm irrigation technologies such as precise irrigation scheduling, fertigation, and automated irrigation systems will not be widely adopted by farmers. This project will research and help develop and implement certain technologies to improve water-use efficiency. Power quality, which is a related issue, will also be researched in so far as it impacts the irrigation districts. The CalPoly Irrigation Training and Research Center (ITRC) will be provided the technical expertise to implement these projects.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of emerging electro-technology applications in agriculture.
- Improving the environmental and public health costs/risks of California's electricity by replacing toxic chemicals used in agribusiness with cleaner electro-technologies.

Proposed Outcomes:

1. Document the implementation of new technologies.
2. Develop a simple procedure for tuning controller constants for automatic upstream control of canal check structures.
3. Develop new devices resistant to plugging or tangling moss for volumetric metering of delivered water - trash shedding propeller meters.
4. Test and evaluate new electronic technologies for volumetric metering of delivered water such as magnetic meters, ultrasonic meters (Doppler), vortex shedding meters and ultrasonic flow-measurement meters.
5. Develop strategies for energy-efficient transition from low-pressure non-reinforced concrete pipe.
6. Verify power quality measurement and conditioning methods.
7. Assess use of variable frequency drives on agricultural pumps.

Project Status:

- New Technology Implementation at California Irrigation Districts project: Researchers published an Infrared Technology for Preventative Maintenance fact sheet and mailed the fact sheet to districts throughout California. The project also documented benefits for variable frequency drive/Supervisory Control and Data Acquisition (SCADA) applications and developed guidelines for ensuring a proper variable frequency drive installation on an existing pump. Please visit:
 - ⇒ <http://itrc.org/reports/doppler/sidedoppler.html>
 - ⇒ <http://itrc.org/reports/vfd/VFDandSCADA.html>
- New Electronic Technologies for Volumetric Metering of Delivered Water – Magnetic, Doppler, Vortex Shedding and Ultrasonic Flow Measurement project: The first season

of field-testing for ultrasonic and magnetic flow meters began at Patterson Irrigation District (PID). A comprehensive field testing report has been prepared that summarizes the design, installation and operation of the McCrometer Ultra Mag, Mace AgriFlo, and Unidata Starflow meters installed at three farm turnouts in PID. Please visit:

⇒ <http://itrc.org/reports/doppler/sidedoppler.html>

⇒ <http://itrc.org/reports/doppler/doppler.html>

- Development of Strategies for Energy-Efficient Transition from Low Pressure Non-Reinforced Concrete Pipe project: Researchers presented a paper at the United States Committee on Irrigation and Drainage, American Society of Civil Engineers meeting in San Luis Obispo in June, regarding the South San Joaquin Irrigation District project. CalPoly researchers completed a re-calibration and update of their main canal gate algorithm to help ensure reliable deliveries to their new project. Hancor is still in the process of testing its new coupler and lining designs. Calpoly has met with the primary Hancor engineering representative in June, and he now anticipates that the new design will be available in early September 2004. Chowchilla Irrigation District's manager has stated a willingness to cooperate with some field-testing. Please visit:
⇒ <http://itrc.org/reports/concretepipe/concretepipe.html>
- Development of a Simple Procedure for Tuning Controller Constants for Automatic Upstream Control of Canal Check Structures project: ITRC contracted with Concepts in Controls to provide a second complete listing of programmable logic controllers (PLC) logic, which will be mapped in a continuing effort to provide better specifications for commercial integrators to follow. There is a delayed purchasing of the Dutch simulation program SOBEK until it is capable of simulating composite check structures – those with both underflow and overflow structures in one location. Work will continue on simulations to refine the tuning mechanism. Please visit:
⇒ <http://itrc.org/reports/cec/tidcanalautomation.html>
- New Devices for Volumetric Metering of Delivered Water - Trash Shedding Propeller Meters: The first season of field-testing for trash shedding propeller meters began at Patterson Irrigation District (PID). A separate comprehensive field testing report has been prepared that summarizes the design, installation and operation of the advanced flow meters installed at two farm turnouts in PID. The McCrometer reverse propeller meter was installed in PID 3N22. The McCrometer propeller meter was read by the ITRC. The Sparling propeller meter has been installed in PID 2N36. The Sparling propeller meter was read by the ITRC. The district operators are periodically checking the flow meter during the season while deliveries are being made. Please visit:
⇒ <http://itrc.org/reports/magnadrive/magnadrive.html>
- Power Quality Measurement and Conditioning project: The project is complete. CalPoly met with a number of integrators and variable frequency drive (VFD) manufacturers. The researchers discovered that the existing specifications (Institute of Electrical and Electronics Engineers (IEEE) standards) were actually designed for allowable harmonics on the supply side of utility transformers, yet in many cases, the manufacturers of VFDs have been held to those standards – even though the harmonics decline appreciably over the transformer. CalPoly researchers also reviewed the specifications regarding phases and ultra frequency (UF) disturbance – factors that influence the life of the motor and disturbance to passersby (audible noise or radio interference). After experimenting with various sensors attached to programmable logic controllers exposed to dirty power, the researchers concluded that there is no potential harm to sensor integrity. Based on what is known now, no more field tests will be conducted. Instead, the research will focus on learning more about how to specify the VFD units themselves to minimize harmonics problems. Because there is no IEEE standard for meaningful VFD controller

specifications, CalPoly will closely examine the various manufacturer specifications and develop an appropriate specification list that protects the motor and the line. The knowledge gained has been continually used to upgrade the VFD specifications that ITRC uses to assist districts. This knowledge is also being used in short courses.

Please visit:

⇒ <http://itrc.org/reports/powerquality/powerquality.html>

Project Status:

The project is active. A new task was added to the contract, and a time extension was allowed for the completion of the task. The task involves conducting research to determine the economic and technical viability of using variable frequency drive controllers on agricultural pumps. All other tasks, except for the newly added task, have been completed and a draft report has been delivered to the PIER program.

Waste Heat Driven Adsorption Chilling in the Food Industry

Contract #: 500-02-004 **Work Authorization #:** UC MR-013

Contractor: Onsite Energy Corporation

Project Amount: \$487,672

Contractor Project Manager: Elizabeth Lowe (925) 358-4272

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

This project demonstrates use of new adsorption refrigeration technology for food processing. Adsorption technology uses low-temperature waste heat to produce refrigeration. This project will demonstrate a 300-ton adsorption chiller installation at a potato chip plant. The plant fries about 20,000 lb/hr of potato chips producing about 15,000 lb/hr of water vapor at about 220 F. This water vapor discharged into the atmosphere at present, will be used as the heat source for the adsorption chiller. The chiller will provide cold water to air condition the plant.

This installation is estimated to save about 1.5 million kilowatt hours (kWh) per year and 300 kW of demand resulting in about \$123,000 of annual saving. When adopted by the food industry in California, this technology will reduce the electricity use for refrigeration thus reduce the overall system load, particularly during the summer. This project is expected to reduce 15 megawatts (MWs) of load during the summer if it is adopted by 50 California food processing plants that have conditions similar to the one at the demonstration site.

This project supports the PIER Program objectives of:

- Optimize energy conservation & resource efficiency by demonstrating use of new adsorption refrigeration technology for food processing that will use water vapor currently discharged into the atmosphere.
- Promote Customer and Utility-owned distributed generation.

Proposed Outcome:

1. Demonstrate that a 300-ton adsorption chiller using water vapor currently discharged into the atmosphere can provide cold water to air condition a potato chip plant.

Project Status:

The project kickoff meeting was held in January 2004 and the initial engineering studies are completed. The commissioning of the refrigeration unit has been delayed due to the closing of the plant and relocation of its operation out of California. At present the contractor is seeking a new site that meets the project's original RD&D objectives.

Waste Heat Driven Chilling Technology for Can Cooker/Cooler Optimization

Contract #: 500-02-004 **Work Authorization #:** UC MR-009

Contractor: DelMonte Foods

Subcontractors: Lawrence Berkeley National Laboratory

Project Amount: \$299,701

Match Amount: \$51,000

Contractor Project Manager: Glen A. Lewis (209) 342-1509

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Active

Project Description:

The project involves a system evaluation and analysis of a can cooker/cooler system common to the fruit and vegetable processing industry. It will identify opportunities for system optimization, including the potential for improving the system energy efficiency by using waste heat to provide process cooling. The project team will identify, design, and commission a chiller technology demonstration and then verify the energy savings and document the reliability of the system improvement. In addition, they will develop a simple, low cost technology applicability tool (interactive software based methodology) to help users identify plants/applications in California where this technology can be replicated.

Potentially the results of this project could reduce the electricity used for refrigeration in food processing in about 200 sites in California that have can-retort system. At the Del Monte site, this process uses about 1.33 million kilowatt hours (kWh) of electricity per year for this operation. This project can potentially reduce that sites use by 1 million kWh per year.

This project supports the PIER Program objectives of:

- Improving energy cost/value by identifying opportunities for system optimization, including the potential for improving energy efficiency by using waste heat to provide process cooling.
- Improving electricity reliability, quality and sufficiency by identifying, designing, and commissioning a chiller technology demonstration and then verifying the energy savings and documenting the reliability of the system improvement.

Proposed Outcomes:

1. Identify opportunities for system optimization, including the potential for improving the system energy efficiency by using waste heat to provide process cooling.
2. Develop a simple, low cost technology applicability tool (interactive software based methodology) to help users identify plants/applications in California where this technology can be replicated.

Project Status:

The project kick-off meeting was held in December 2003. The first phase of data collection and analysis for the Del Monte site is complete. The engineering study of the waste heat recovery and refrigeration is also completed. The system optimization analysis concluded that the waste heat availability was inadequate to implement a waste heat driven refrigeration unit. Topping cycle involving steam turbine driven chilling system was found to be more energy efficient and also cost effective. This option was favored by the plant management.

The first critical project review was conducted on December 9, 2004. The proposal by the plant management to install an 86-ton steam turbine driven chilling unit was discussed during the meeting. This proposal was further evaluated and approved by CEC. This involves a change of scope of the project but no change in the CEC component of the project cost.

The project is pushed back by about one year. Installation of the steam driven chiller is expected to be completed for operation prior to the 2005 processing season subject to the approval of the project by Del Monte management.

Water and Wastewater Energy Efficiency Roadmap

Contract #: 500-01-040 **Project #:** 1

Contractor: American Water Works Assoc Research Foundation

Subcontractors: McGuire Environmental Consultants

Project Amount: \$25,000

Match Amount: \$25,000

Contractor Project Manager: Linda Reekie (303) 734-3423

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Active

Project Description:

The purpose of this project is to develop a research, development, and demonstration (RD&D) plan to improve the energy efficiency of water and waste water treatment. In addition, this project entails prioritizing and selecting RD&D projects that would be funded jointly by the American Water Works Assoc Research Foundation (AwwaRF) and the PIER program.

The availability of clean water at a low cost is essential to California's economy and continued prosperity. California needs to treat large quantities of water to meet both municipal and waste discharge requirements. These activities are heavily dependent on electricity. Water treatment facilities in California use 4 percent of all the electricity used in California.

The PIER Industrial/Agriculture/Water (I/A/W) program will focus on RD&D activities that help improve the energy efficiency of water for urban, industrial and agricultural consumption and efficient treatment of wastewater. AwwaRF sponsors research to help water utilities provide high-quality water, infrastructure reliability, environmental leadership, and efficient and customer-responsive organizations. Success with AwwaRF on the Technology Roadmap could lead to future collaborative efforts.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by helping water utilities improve the efficiency of their use of water consumption and treatment.
- Improving the environmental and public health costs/risk of California's electricity by using less energy to provide and treat water.
- Improving the safety of California's electricity by helping provide low-cost clean water.

Proposed Outcomes:

1. Develop a Technology Roadmap for Water and Wastewater Treatment Technologies. The purpose of the Technology Roadmap will be to identify and prioritize research opportunities aimed at energy efficiency, cost and reliability affecting water and wastewater utilities.
2. Fund up to three projects identified as the highest priorities from the Technology Roadmap.

Project Status:

The Technology Roadmap has been completed and AwwaRF has awarded contracts for the two highest priority projects from the Technology Roadmap. The two projects are:

- Development of a Utility Energy Index to Assist in Benchmarking of Energy Management for Water and Wastewater Utilities.
- Zero Liquid Discharge and Volume Minimization for Inland Desalination.

IAW Projects Completed in 2004

Acoustic Stimulation for Aluminum Castings to Conserve Metal and Electricity

Contract #: 500-02-024

Contractor: California Cast Metals Association

Subcontractors: Simonelli and Associates : Furness-Newburge, Inc. : Technikon

Contract Amount: \$135,500

Match Amount: \$88,500

Contractor Project Manager: James Simonelli (916) 933-3062

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Completed

Project Description:

The purpose of this project is to develop and demonstrate acoustic stimulation technology at the aluminum foundries in California to reduce energy use in the metal casting process. The technology consists of an audio device vibrating at lower than ultrasound frequencies at high amplitudes inserted into the risers of molds for metal castings.

Laboratory tests have shown acoustic stimulation will lower pouring temperatures and delay solidification of molten metal. These tests were performed on simple bar molds. The next step is to demonstrate the technology using industrial molds at an actual foundry to facilitate industry acceptance and commercialization.

Test castings that used acoustic stimulation showed improved mechanical properties versus the metal from castings that did not use acoustic stimulation. But the main advantage is energy and metal savings by increasing the yield of metal castings. Yield is determined from the weight of the pour minus the weight of the metal left in the risers, which is waste. Risers must be large enough and at sufficiently high temperatures to keep the metal liquid to fill voids formed in the mold as the casting cools and contracts. Acoustic stimulation will make the metal more fluid and improve liquid flow, which will allow smaller volume risers to fill voids.

A successful application of the technology will be on thin wall castings. Thin wall castings require superheating to fill the thin sections of the mold, which can degrade the metal. If acoustic stimulation could be used on thin wall castings without superheating, it could produce better thin wall castings in addition to saving energy and metal.

The technology developed and demonstrated under this project will benefit aluminum foundries, of which there are at least 75 in the State, more than any other type of metal foundry. After it is established in the aluminum foundries, the technology can be adjusted to other metals such as iron, steel, brass and bronze.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity.
- Improving the environment, public health and safety.
- Improving electricity reliability, quality and sufficiency.
- Strengthening the California economy.

Proposed Outcomes:

1. Build and test an acoustic stimulator adapted for foundry molds.
2. Complete a series of pours on thin wall molds with and without acoustic stimulation.
3. Determine electricity and metal saved using acoustic stimulation.
4. Technology transfer to the metal casting industry.

Actual Outcomes:

1. Built and tested an acoustic stimulator adapted for foundry molds.
2. Completed a series of pours on thin wall molds with and without acoustic stimulation but further research is needed to apply the technology on thin wall pattern sand molds.
3. The Project succeeded in demonstrating energy savings and waste metal reduction from lower pour temperatures in an aluminum foundry.
4. Made technology transfer to the metal casting industry.

Project Status:

The project has been completed.

Final Report Title: Acoustic Stimulation for Aluminum Castings To Conserve Metal & Electricity

Publication Number: 500-04-090F

Publication Date: November 2004

PIER Web Location: www.energy.ca.gov/pier/final_project_reports/500-04-090f.html

Energy Efficiency Roadmap for Petroleum Refineries in California

Contract #: 500-03-010

Contractor: Energetics, Incorporated

Contract Amount: \$42,992

Contractor Project Manager: Joan Pellegrino (410) 953-6202

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Completed

Project Description:

This contract with Energetics, Inc. is enabled by a grant from the U.S. Department of Energy (DOE), for developing an energy efficiency RD&D roadmap for the petroleum refineries in California.

In 2002, the PIER program was awarded a grant by the U.S. DOE's State Industries of the Future (SIOF) program to develop a roadmap that would identify petroleum industry issues, priorities, and options for increasing energy efficiency. The \$185,000 federal grant required that the PIER program develop a roadmap for further RD&D investments in California. The DOE grant specified that the roadmap be developed through a workshop involving industry participants.

The petroleum refining industry (Standard Industrial Classification #32411) in California is concentrated in two areas: the Los Angeles basin and San Francisco Bay. The industry is an important economic factor in these areas, providing nearly 10,000 jobs directly and a multitude of indirect employment. Value of shipments in 1997 was just over \$19 billion. A variety of companies operate refineries in California, including Chevron-Texaco (partnered with OIT), BP-ARCO, and Valero. It is also the single largest energy-consuming sub-sector in California. Energy is the key ingredient in the conversion of crude oil to clean refined petroleum products. Increased demand for light oil products, combined with the efforts to reduce sulfur content in gasoline and the replacement of MTBE by ethanol will lead to increased energy expenditures. As most refineries are near urban areas, continued public pressure on the environmental performance of refineries leads to increased interest in pollution prevention. Increasing production in an environmentally sound manner, while reducing energy consumption through development and implementation of innovative technologies, is essential for the development of a sustainable oil industry in California.

Petroleum refineries are the single largest industrial consumer of electricity in California. In the year 2000, refineries consumed 6.230 GWh of electricity. In addition, this segment is also the second largest industrial user of natural gas and consumed 1,432 million therms. Although the refineries produce a vast amount of electricity themselves, they are always looking for increasing reliability and reducing the energy input per barrel of refined output.

This project supports the PIER Program objective of:

- Addressing important RD&D gaps by identifying and laying out a technology roadmap for meeting the priority RD&D needs of California's petroleum refineries.

Proposed Outcomes:

1. Conduct a technology roadmap workshop.
2. Develop a roadmap that will identify petroleum refining industry issues, priorities, and RD&D opportunities for increasing the energy efficiency in petroleum refineries in California.

Actual Outcomes:

1. The workshop was held in Los Angeles on January 14, 2004. The participants at the workshop consisted of refinery engineers, energy or facilities managers, and consultant and research institutions that are familiar with the refinery processes. Because California's environmental regulations and petroleum product mix differ from other states, the nature and scope of energy issues for California are markedly different. Thus the RD&D focus needs a separate assessment.

The technology roadmap workshop helped the PIER staff establish a working relationship with the petroleum refineries in California and also helped the PIER staff better define, understand and mitigate the energy efficiency issues affecting this industry. Since this segment of industrial ratepayers is the largest user of energy in California, the outcome of this workshop and the resulting report helped the PIER program potentially develop a RD&D agenda for energy efficiency that is responsive to this industry's needs. The key contract deliverable -- the RD&D roadmap -- is the foundation for such work. In addition, work in this area will help meet the goals set under Commission's Energy Action Plan.

2. A major California utility is using the technology roadmap to develop its Public Goods Charge (PGS) funded energy efficiency programs for the petroleum refinery industry.

Project Status:

This project has been completed within the budget.

Final Report Title: Energy Efficiency Roadmap for Petroleum Refineries in California

Web Location: www.eere.energy.gov/industry/petroleum_refining/pdfs/refining_roadmap.pdf.

Gas Fired Hot Water Heat Pump ThermoSorber for Food and Beverage Industry

Contract #: 500-01-028

Contractor: Energy Concepts Company

Subcontractors: NOVA Greening

Contract Amount: \$240,000

Match Amount: \$80,000

Contractor Project Manager: Donald Erickson (410) 266-6521

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Completed

Project Description:

The purpose of this project is to demonstrate a gas-fired hot water heat pump ThermoSorber in the food and the beverage industries. The proposed technology approximately doubles the energy efficiency by co-producing the hot water and the chilling concurrently. This technology is projected to reduce the consumption of the natural gas by 40 percent in the hot water production, and reduce the chilling production cost by as much as 80 percent. The economic payback of reducing the gas and electric utility costs is less than two years. Even at this early commercialization stage, the technology has great market potential.

Many food and beverage industries require storage applications and heating and cooling processes. Gas-fired boilers supply the heat while electrically driven refrigeration systems provide the cooling. The cost of the energy consumed by these devices is a major concern of the industry. Gas-fired, hot water heat pump ThermoSorbers transfer heat from lower temperature to a higher temperature. In effect, ThermoSorbers produce both the cooling and the heating concurrently using a fraction of the total energy. The industry, however, was not familiar with this technology and had doubts about its performance until the PIER project demonstrated its operations and energy saving potential.

This project supports the PIER Program objective of:

- Improving the energy/cost value of California's electricity by significantly reducing the use of natural gas used to heat water and the production cost of chilling used in the food and beverage industry in California.

Proposed Outcomes:

1. Reduce the consumption of natural gas by 40 percent in the hot water production along with 80 percent reduction in electric use by co-producing chilling.
2. Demonstrate a high-efficiency, gas-fired hot water heat pump ThermoSorber technology, which transfers the heat from a lower temperature to a higher temperature, and produces the cooling and heating at the same time using a fraction of total energy.

Actual Outcomes:

1. Reduced the consumption of natural gas by 40 percent in the hot water production along with 80 percent reduction in electric use by co-producing chilling.
2. Demonstrated a high-efficiency gas-fired hot water heat pump ThermoSorber technology.

Project Status:

- The kick-off meeting was held at the California Energy Commission on May 6, 2002.
- Several demonstration sites were selected for application requirements. These included breweries, processing plants and a major dairy. However, due to economic considerations, only one was finally selected. The contractor designed the plan and

prepared a draft test plan that defines the testing procedure and methods of monitoring the performance of the ThermoSorber unit.

- The first ThermoSorber unit was installed at Squab Valley Company, Modesto on March 12, 2003 and is running well.
- The capacity for water storage at the Squab plant was augmented to optimize the use of this technology for plant conditions specific to the Squab processing plant. This addition substantially improved the economics of the plant operation.
- California Institute of Food and Agriculture Research (CIFAR) is currently making an independent assessment of the economic performance of this new technology.
- The final meeting at the conclusion of the project was held on December 28th, 2004 where the potential sites for the second demonstration were discussed.
- The contractor will submit the final report to the contract manager February 2005.
- A new contract will be written up once a second demonstration site is found to confirm the results of the first demonstration. The \$40,000 balance left in this contract will be used for the second demonstration.

Methodology to Optimize Compressed Air Energy Efficiency for Industry

Contract #: 500-01-026

Contractor: Southern California Edison

Contract Amount: \$178,000

Contractor Project Manager: Babu Joseph (626) 633-7177

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Completed

Project Description:

The purpose of this project is to develop a benchmark and the methodology to quantify the central plant efficiency of compressed air systems. Compressed air is the fourth largest commonly used utility in the industrial operation after the electricity, natural gas and water. At present, the efficiency of an individual air compressor unit is well established and has a recognized benchmark. However, the entire compressed air system in a plant has no quantitative benchmark for efficiency. The lack of this benchmark based on empirical evidence (rather than by inference) has made it difficult to develop an optimum operating strategy and has inhibited accurate measurement of energy efficiency improvements.

There are numerous California industries that use compressed air as the plant energy source. There are methods available in the industry to control the efficiency of the compressor but there are no accurate methods available, at the present time, to optimize the efficiency of the compressed air system in a central plant. In most plants, there are many opportunities for energy conservation related to the generation, distribution and use of the compressed air. An estimated 30 percent of the total energy cost of the central plant is from the compressed air energy system. In some industries, the waste of energy associated with the compressed air system is as high as 40 percent. Consequently, the penalty for the improper management of the compressed air energy system is very high and there is a need for the methodology to quantify the central plant efficiency of the compressed air system.

This project contributes to the PIER program objective of:

- Improving the energy cost/value of California's electricity by helping create the methodology to quantify efficiency of Compressed Air Energy Storage (CAES) systems in a central plant.

This project is also supported by the Emerging Technology Coordination Council (ETTC), Pacific Gas & Electric, San Diego Gas & Electric and a group organized under the California Public Utilities Commission (CPUC) directive. The contractor will make the findings and reports available to all the utilities and their industrial customers.

Proposed Outcomes:

1. Establish the benchmark and develop the methodology to quantify the efficiency of the central plant's compressed air systems.
2. Assist California utilities in providing an acceptable process for energy efficiency rebate programs.
3. Provide industrial customers an acceptable procedure to assess system performance and to evaluate their systems against other systems.
4. Disseminate information generated by this project to industry stakeholders via papers, presentations, workshops, etc.

Actual Outcomes:

1. Established the benchmark and developed the methodology to quantify the efficiency of the central plant's compressed air systems.
2. Assisted California utilities in providing an acceptable process for energy efficiency rebate programs.
3. Provided industrial customers an acceptable procedure to assess system performance and to evaluate their systems against other systems.
4. Disseminated information generated by this project to industry stakeholders via papers, presentations, workshops, etc.

Project Status:

- The project start-up industrial meeting was held at Southern California Edison (SCE) offices. Participants at this meeting identified the applicable metering devices for the flow measurement, identified the customer sites that were good candidates for the instrumentation and testing, and selected the six sites for the testing.
- The contractor purchased all measurement devices for the testing. The flow, static pressure and temperature devices were calibrated.
- The concept development and development of the calibration methodology was completed. The methodology for developing the CAES index was tested at six different industrial sites, and was found to be accurate, robust and easy to implement.
- The contractor successfully finished the testing at the six customer sites in the SCE territory. The industrial customers are happy with the results of the testing. SCE has started giving rebates to those industrial customers who are using this methodology to quantify the efficiency of their central plants' compressed air systems.
- Two workshops were held to explain this technology to compressed air professionals and the California public. One was held in Southern California (Irwindale) and the other was held in Sacramento. Several companies in California have shown interest in applying this methodology at their expense.
- The project is completed within the budget and has achieved its goals.
- The contractor will submit the final report to the Contract Manager in February 2005.

Power Quality Knowledge-Based Services (EPRI Program #97)

Contract #: 500-02-028 **Project #:** 20

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$25,000

Contractor Project Manager: Bill Howe (303) 417-1514

Commission Contract Manager: Mike Gravely (916) 834-3127

Status: Completed

Project Description:

The Power Quality Knowledge-Based Services program provides the essential information and resource tools needed to help Energy Commission Staff understand the economic losses, industrial process impacts and other factors that power quality disturbances cause California industrial and agricultural end users. The program offers a comprehensive collection of technical and informational publications and products, educational forums, technical support, and web-based services to enable staff to efficiently deal with today's power quality issues, planning, mitigation, and prevention.

The program provides four electronically distributed newsletters *Signature*, *Current Connections*, *TechWatch* and *PQNews* which regularly provide the latest information on power quality business, technical trends, educational opportunities, and project updates. A power quality case study library is available to Commission Staff and other EPRI funding members to reference when desired.

The Power Quality Knowledge-Based Services Program also provides Commission Staff access to special projects technical reports designed to help build a knowledge base of the latest power quality information, tools, products, and expert insights into power quality, provide late-breaking news on emerging power quality technologies and market trends.

This project supports the PIER Program objective of:

- Optimizing Energy Conservation & Resource Efficiency by providing guidance on methods to enhance and improve system power quality and increase the efficiency of the utility network.

Proposed Outcomes:

1. Subscribe to EPRI's *Signature* newsletter.
2. Subscribe to EPRI's *PQ News* newsletter.
3. Subscribe to EPRI's *Current Connections* newsletter.
4. Subscribe to EPRI's *TechWatch* newsletter.
5. Subscribe to EPRI's Power Quality area on EPRIweb.

Actual Outcome:

1. All subscription services received.

Project Status:

1. Electronic Publications and Technical Resources: *Subscription to EPRI's PQ Knowledge-transfer electronic publications and resources*. EPRI Product ID # 1008535.
2. EPRI PQ Encyclopedia: *A definitive desk reference of PQ phenomena, guidelines, mitigation techniques, and management strategies*. Review for advisories was conducted September 2004. EPRI Product ID #1008536.

3. PQ Knowledge Transfer: *Access to the Power Quality area on EPRIweb*. Review meeting with funders was conducted in September. Content continues to be updated weekly. EPRI Product ID # E215298.
4. PQ Consulting and Training: *The PQ Hotline*. The PQ Hotline is active and is fielding inquiries daily. EPRI Product ID # E215299.
5. PQ Events and Forum. Two PQIG events have been completed in 2004. *PQIG North America, October 5-6, 2004, Nashville TN. PQIG International, September 12-13, 2004, Fukuoka, Japan, sponsored by Kyush Electric*. EPRI Product ID # E215302.

The project was completed in December 2004.

RD&D Program Development for Ensuring Energy Supply for California's Electronics/E-Commerce Industries

Contract #: 100-98-001 **Project #:** 48

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: EPRI PEAC Corporation : Global Energy Partners, LLC

Project Amount: \$960,000

Contractor Project Manager: Ellen Petrill (650) 855-8939

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to identify the issues affecting California's electronics and high-tech industry and to develop a comprehensive technology research, development and demonstration (RD&D) roadmap in collaboration with the industry to ensure a reliable energy supply to California's electronics industry. This project also entails developing and/or demonstrating candidate technologies that enhance supply reliability and the ability of the industry to manage energy during an energy crisis. Recent (2001) disruptions in California's electricity supply and escalating energy costs pose serious threats to this industry, which is a substantial contributor to the State's economic growth.

The project developed a comprehensive RD&D plan that 1) provides short-term robust remedies to the recent energy crisis, and 2) maps a RD&D action plan that will reinforce the confidence of the electronics industry in California's energy infrastructure for the longer term. This plan will be used to provide the PIER program guidelines for future RD&D projects and efforts.

This project supports the PIER Program objectives of:

- Optimizing energy conservation & resource efficiency by developing a comprehensive RD&D plan.
- Strengthening California's economy by enhancing the high-tech industry's ability to obtain reliable energy at a reasonable cost.

Proposed Outcomes:

1. Develop an RD&D program plan that provides immediate and intermediate (five years maximum) solutions to help the electronics industry meet the energy challenge in California.
2. Implement a fast-track program through technology development and demonstrations that help mitigate urgent problems faced by the industry.
3. Transfer program results to principals in the industry to gain maximum utilization in order to attain PIER program goals.

Actual Outcomes:

1. RD&D Plan and Roadmap for Enhancing Energy Efficiency and Supply Reliability for California's Electronics Industry was completed.
2. Two fast-track programs were implemented as part of this effort. The first was the application of ultracapacitor technology to improve industrial process reliability in a large manufacturing facility, and the second was the development of a real-time information tool to demonstrate the capability to provide industrial end users real-time energy cost information management.

3. Several technology transfer presentations were provided to industrial associations and California industrial companies to ensure the lessons learned in this effort were provided directly to the appropriate California end uses.

Project Status:

The project reports will be available May 2005.

IAW Projects Completed in 2003

Advanced Distillation

Contract #: 100-98-001 **Project #:** 36

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$100,000

Match Amount: \$2,500,000

Contractor Project Manager: Ed Fouche (919) 515-7550

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to determine more precisely the potential benefits to the state of California of implementing advanced distillation within the state. Advanced distillation technology includes a number of enhancements to a design concept called “distributed distillation,” which is an energy optimization analysis that aims to eliminate inefficiencies in conventional distillation. Advanced distillation can typically reduce energy use requirements, cooling water requirements, and environmental emission per pound of distillate by 50%. Any industry that uses distillation can potentially benefit from advanced distillation. The two industries that use the most distillation are petroleum refining and the hydrocarbon portion of the chemical industry (which includes industrial organic chemicals, plastics, organic detergents, organic pesticides and agricultural chemicals, and adhesives and sealants).

This project supports the PIER Program objectives of:

- Improving energy cost/value.
- Improving the environment, public health and safety.

Proposed Outcomes:

The study will be conducted in two phases: In Phase I, researchers will determine the current California distillation energy use profile by industry segment and type of distillation. The project will also identify industry segments that would benefit most from application of advanced distillation technology.

In Phase II, EPRI will assist the Commission with participation in a technical study, sponsored by British Petroleum and the US DOE, to determine the energy savings of advanced distillation for an ethylene plant in California.

Actual Outcomes:

In Phase I, researchers identified the current distillation energy use profile in California by industry segment and type of distillation. The team also determined the industry segments in California that would obtain the greatest benefit from advanced distillation methods.

Results indicated that if a conservative 25% of all existing distillation within the state is revamped using advanced distillation, the annual thermal energy savings is estimated to be 52 trillion Btu. Another 5 trillion Btu in annual savings could be achieved in potential near-term new chemical plant construction. The value of this potential 57 trillion Btu/yr savings is:

- \$142,500,000 (at a \$2.5/mmBtu fuel cost)
- \$285,000,000 (at a \$5/mmBtu)
- \$570,000,000 (at \$10/mmBtu)

Overall electricity savings would be about 1% of the thermal savings (about 200 megawatts). In addition to fuel savings and electricity savings, capital cost savings of up to 40% or more could be achieved, representing savings on the order of \$800 million. Additional revenue could be realized through increased production. For the California petroleum refining industry (which represents more than 82% of the potential energy savings), the 25% of revamped distillation represents a 25% or more increase in production, which is worth on the order of \$1 million per year in additional profit at a conservative \$0.5/BBL profit margin.

The 57 trillion BTU/yr energy savings has an associated decrease in air pollution, water use, and wastewater discharges (including decreases of about 15 million ton/yr in carbon dioxide, 7,000 ton/yr NO_x, 27 million tons/yr fresh water, and 1.5 million tons/yr wastewater).

Project Status:

Phase I is complete and covered in EPRI Report 1006719. Phase II of the study was cancelled because Phase I revealed there were no ethylene plants in California. Project is complete.

Effects of Chlorine Dioxide Preoxidation on Ozone Demand and Energy Consumption

Contract #: 500-00-024

Contractor: Contra Costa Water District

Contract Amount: \$130,000

Contractor Project Manager: Peter Zhou (805) 688-8370

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to evaluate the impact of chlorine dioxide preoxidation on ozone demand, and thus energy consumption, at a water treatment plant in the Contra Costa Water District. The project will assess partially substituting ozone with chlorine dioxide for preoxidation because ozone use is energy intensive.

This project supports the PIER Program objectives of:

- Improving energy cost/value of California's electricity by quantifying the energy and cost savings when preoxidizing water with chlorine dioxide.
- Improving the environment, public health and safety by providing improved-quality water using less electrical energy.

Proposed Outcomes:

1. Potential reduction of electrical load between 3.7 MW to 6.9 MW.
2. Develop a relationship between the chlorine dioxide dose and ozone demand and bromate formation.
3. Quantify chlorate formation after ozone application to the preoxidized water.
4. Establish the effects of chlorine dioxide preoxidation on coagulation and settling prior to ozonation.
5. Quantify the energy and cost savings when preoxidizing the water with chlorine dioxide.

Project Status:

The work on design specifications and development of a test plan commenced on June 1, 2001 using Contractor's match funds. The kick-off meeting starting Energy Commission involvement was held on November 13, 2001 at Contra Costa Water District's Randal Bollman Water Treatment Plant in Oakley, California. The experimental work is almost completed and the data is being analyzed. First draft of the Final Report was submitted in November 2002, and is being revised by the contractor to incorporate Contract Manager's comments. Technology transfer workshop is tentatively scheduled for early March 2003. The work on this contract is on schedule.

Emerging PQ Mitigation Product Demonstration at Customer Sites

Contract #: 100-98-001 **Project #:** 39

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: EPRI PEAC Corporation

Project Amount: \$60,000

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project description:

This project's goal is to obtain real-life application experience with emerging power quality mitigation technology through demonstrations at customer sites. The demonstrations will enable the project team to characterize the limitations of the technology and identify opportunities for improvement. Customers involved in demonstration projects will obtain experience with the technology and will be able to train personnel in its application.

Power quality concerns continue to be an important factor affecting the productivity of California industries. The Commission is facilitating the development of new power quality mitigation hardware for customers. This project will take the technology development into the next step of demonstration projects to obtain experience and develop expertise in the application of the technology.

This project supports the PIER Program objectives of:

- Improving the Reliability/Quality of California's Electricity by developing knowledge and procedures to solve power quality problems that cause equipment failures and process disruptions.
- Improving the Energy Cost/Value of California's Electricity by reducing process inefficiency associated with power quality disturbances.

Proposed Outcomes:

1. Obtain experience and develop expertise in the application of new and emerging PQ mitigation hardware.
2. Characterize limitations and help identify opportunities for improvement of new technology developments in practical applications.
3. Develop estimates for operating and maintenance requirements as a function of the applications for the technology.

Actual Outcomes:

In 2001 the project team conducted site audits to determine the best location for demonstration. In addition, the requirements for PQ mitigation were determined for those sites.

The field demonstration was conducted in 2002. The device installed was a neutral current filter. The intent of the demonstration was to determine the extent to which the device helped to conserve energy. Energy savings are possible due to the blocking of third harmonic current in the neutral conductor. This is applicable for single-phase non-linear loads supplied by a wye-connected transformer secondary. The measured results indicated that a small amount of energy savings is achieved, through the reduction of I^2R losses in the neutral conductor. The payback time for the filter, based on those savings alone, was calculated. The Commission will now be able to show, for interested customers, that these filters can pay for themselves through energy savings, and also estimate how long that will take.

Project Status:

The project has been completed.

Energy Efficiency Measures for High Tech Buildings, Clean Rooms and Laboratories

Contract #: 400-00-020

Contractor: Lawrence Berkeley National Laboratory

Subcontractors: Northwest Energy Efficiency Alliance : United States Department of Energy : ASHRAE : Sematech, Inc. : Major Energy Users Group (MEUG) : EPA/FEMP Laboratories for the 21st Century : University of California, Office of the President : California State University

Contract Amount: \$652,000

Match Amount: \$125,000

Contractor Project Manager: John Kesselring (650) 855-2902

Commission Contract Manager: Tony Wong (916) 654-4015

Status: Completed

Project Description:

The purpose of this project is to research and develop design tools and a guidebook for energy efficient cleanrooms for high-tech industries and laboratories. Laboratories and cleanrooms serve the semiconductor, electronics, bio-pharmaceutical sectors. In addition, the contract will evaluate and support field demonstrations and tests of the low-flow fume hood.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity to electric ratepayers by reducing energy use or improving energy efficiency in the industrial sector.

Proposed Outcomes:

1. Develop a cleanroom facility planning guide that provides guidance to cleanroom owners and designers in setting and implementing an energy strategy in the programming process, prior to detailed design.
2. Evaluate field performance of a low-flow fume hood and identify design improvements.
3. Complete development of a laboratory design intent tool that will allow laboratory designers to effectively document their approach and expectations related to energy performance and design throughout the life of the facility.
4. Develop a more comprehensive roadmap that will identify additional research needs, needed energy technologies for high-tech buildings, energy systems with the most potential for energy savings.

Actual Outcomes:

The Cleanroom Programming Guide was completed (LBNL report number 49223) and issued for trial use in December 2001. Copies of laboratory design intent tool were distributed to attendees at the "Laboratories for the 21st Century" conference in October 2002. A case study was completed for a proposed laboratory facility at UC Merced. High priority research tasks as identified by the roadmap process and subsequent survey of industry participants were presented at the Silicon Valley Manufacturers Group meeting in May 2002. A technology roadmap for High-performance Laboratories and Cleanrooms was completed (LBNL report number 50599). A final report has been prepared for the above three tasks.

The development and demonstration of the six-foot Berkeley hood has encountered some problems. First, the delivery of the prototype was delayed from the manufacturer and required extensive corrective re-construction. Second, the process for obtaining a variance from Cal/OSHA for field demonstration has taken more time than anticipated. Currently, LBNL staff are working with Cal/OSHA Standards Board staff to seek an interpretation from the American

National Standards Institute regarding an equivalent performance indicator for “traditional” face velocity. This interpretation would be used to evaluate laboratory-type hoods having design features that do not use traditional face velocity as their method of containment.

Project Status:

The project has been completed.

Energy Efficient Data Centers

Contract #: 500-01-024

Contractor: Lawrence Berkeley National Laboratory

Subcontractors: Rumsey Engineers, Inc.

Contract Amount: \$500,000

Match Amount: \$100,000

Contractor Project Manager: William Tschudi (510) 495-2417

Commission Contract Manager: Paul Roggensack (916) 654-6560

Status: Completed

Project Description:

The purpose of this project is to benchmark energy use in data centers and to develop a roadmap to guide research that will increase the energy efficiency at data centers. Data centers are prevalent in many buildings and are an important part of the California economy. These facilities use a large amount of energy. Rapid expansion of information technology and improvements has created a unique challenge to California's power grid.

Data centers are becoming more energy intensive in smaller spaces. Computer power is increasing dramatically while system components shrink. An example of the increased demand for energy use in data centers is the development of the World Wide Web. New Internet "server hotels" are being proposed across California and the nation. Unfortunately, energy efficiency has not evolved as rapidly as component size reduction and other technological improvements.

In addition to increased energy demand from data centers, there is discrepancy between projected electrical demand by developers and building owners and actual electrical consumption. This leads to inefficient operation because there is a tendency to overstate the electrical load of these facilities and their impact on regional power grids. Outdated cooling practices also lead to inefficient operation.

Phase 1 of this project will provide an energy end use breakdown from representative data center facilities. This will result in development of standards and measurements to determine energy efficiency of data centers. The result will be a design guide to enable building planners use a systems approach to design energy efficient data centers.

Phase 2 of this project will develop a roadmap to guide research and market transformation of new technologies for data centers. LBNL will work with industry experts through workshops and surveys to obtain the necessary information to develop the roadmap. The roadmap will provide continuous improvement in energy performance and address opportunities for both retrofit and new construction for data center facilities.

This project supports the PIER Program objectives of:

- Improving energy cost/value by developing a roadmap to guide research that will increase energy efficiency at data centers.
- Improving electricity reliability, quality, and sufficiency by providing data on potential energy savings in a design guide for building planners that can lead to more efficient operations of data centers as they continue to expand across California and the world.

Proposed Outcomes:

1. Six benchmark studies that categorize energy end use at data centers and will provide a guide for designers and builders of data centers.

2. A roadmap to guide research and market transformation for future technologies at data centers.

Actual Outcomes:

1. A total of ten benchmark studies completed.
2. Energy Efficiency Data Centers Roadmap completed.

Project Status:

The project has been completed.

Energy Storage and Power Electronics for Power Quality Solutions

Contract #: 500-02-028 **Project #:** 14

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$66,300

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

This multi-member program provides the Commission staff with the latest data, information, and knowledge about power electronics and energy storage solutions that can be applied inside a California end-user's facility or within a utility T&D system as a widearea PQ solution to help eliminate these costly PQ disturbances. In the global marketplace, all companies must rely increasingly on superior innovation for competitive advantage. Sponsoring this program and providing its research results to California end-users can help enhance productivity and ensure the competitiveness of California commerce and industry. This program offers expert insight into power conditioning issues, along with guidance on the proper selection, application, and installation of power quality mitigation hardware.

Energy Storage and Power Electronics for PQ Solutions consists of four multi-year projects that deliver specific products for each funding year. These projects will help bring to market original equipment that has greater immunity to power quality disturbances and provides more cost-effective solutions to end users, reduce up-front engineering expenses, increases end user productivity, provide higher utilization value for power quality mitigation technology, increase system efficiency, help reduce electromagnetic fields and environmental impacts to air quality, provide knowledge for the proper application of emerging power quality mitigation technologies, and provide end-users with credible performance data for new power conditioning technologies. This multi-year approach is key to developing a long-term plan that effectively addresses next-generation power conditioning and energy storage issues.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on the efficient use of electric energy storage by the California industrial end users.

Proposed Outcomes:

1. Embedded Solution for Internet and Telecommunications Industries: Testing and design evaluation assessing the uptime requirements of process equipment in industry, and identifying advanced technologies as embedded solutions. Technical Report.
2. A workshop to introduce new equipment immunity standards to industry stakeholders will be scheduled in 2003.
3. Design Specification, Test Methodology, and Application Guide for a Hybrid Multi-Energy System for Power Quality Mitigation. Technical Report.
4. Technology Assessment and Application Guide for Emerging Power Quality Mitigation Hardware. Technical Report.

Actual Outcomes:

1. Technical report on Embedded Solution for Internet and Telecommunications Industries: Testing and design evaluation assessing the uptime requirements of process equipment in industry, and identifying advanced technologies as embedded solutions.

2. A workshop with industry stakeholders was held in September 2003.
3. Technical report on Design Specification, Test Methodology, and Application Guide for a Hybrid Multi-Energy System for Power Quality Mitigation.
4. Technical report on the Technology Assessment and Application Guide for Emerging Power Quality Mitigation Hardware.

Project Status:

The project has been completed.

Improving Power Quality Immunity in Industrial and Commercial Equipment

Contract #: 500-02-028 **Project #:** 11

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$20,790

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The project will develop a series of case studies to help Commission staff members understand the likely causes of power quality problems and to better understand what California Industrial end users can do to make equipment more efficient and less susceptible to electrical disruptions. The case studies will be written from the end user perspective and will illustrate how to improve the power quality immunity of end-use equipment. They will provide technical and economic information for different end-use segments, as identified by the program advisory group. The number and type of case studies will be determined by total amount of funding provided by all the project sponsors. The project also will deliver a final report discussing equipment immunity issues and investigation methodologies for stabilizing the electrical supply network.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on methods to optimize the system power quality and the efficient use of electric energy by California industrial end users.

Proposed Outcomes:

1. Technical Report on Improving Power Quality Immunity in End-Use Equipment Case Studies.
2. Technical Report on Impact of SEMI F47 Power Quality Immunity Standard on Utility and Customers.
3. Technical update on Improving Power Quality Immunity in End-Use Equipment Case Studies.

Actual Outcomes:

1. Technical Report on Improving Power Quality Immunity in End-Use Equipment Case Studies.
2. Technical Report on Impact of SEMI F47 Power Quality Immunity Standard on Utility and Customers.
3. Technical update on Improving Power Quality Immunity in End-Use Equipment Case Studies.

Project Status:

The project has been completed.

Industrial Design Guide Enhancements

Contract #: 500-02-028 **Project #:** 12

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$24,310

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The EPRI Industrial Design Guide (IDG) provides a strong technical basis for working with industrial end users in power quality, distribution, and economic development activities. It describes in detail such industrial processes as injection-molded plastics and CNC machining, includes electrical diagrams of the processes and sub-processes, and discusses the economics of process-associated downtime. The descriptions and drawings are interactive, leading the user to important power quality and energy efficiency considerations such as sensitive components, test protocols, solutions, applications, and relevant case studies. This authoritative guide to industrial processes can be used to enhance the technical understanding and credibility of all Commission staff as they interface with California Industry end users.

This 2003 project will add descriptions, diagrams, and economic evaluations of new industrial processes to the IDG Web site under EPRIweb. Additional processes will be included as the information is developed and formatted during the year, along with information from system compatibility research and forensic examination of failed equipment, so the site is continually updated. The project will also produce an updated CD version of the guide at the end of the year. The project results will provide a comprehensive knowledge base of California industrial processes.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on methods to optimize the system power quality and the efficient use of electric energy by California industrial end users.

Proposed Outcome:

1. Industrial Design Guide: Updated Web and CD versions.

Actual Outcome:

1. Industrial Design Guide Technical Report and CD.

Project Status:

The project has been completed.

Multi-Energy Park Application

Contract #: 500-02-028 **Project #:** 13

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$17,380

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

This project is the continuation of an EPRI managed multi year effort to develop the optimum configuration of multi-energy devices to provide improved power quality as well as high efficiency and reliability. This 2003 work focused on:

- Baseline power quality requirements for Clarkson.
- Power generation plant dynamics during various modes of operation and transitions from one mode to another.
- Campus electrical system short circuit studies to determine required breaker ratings.
- Generator protection and utility system impact studies (connection requirements and needs for Niagara Mohawk).

The multi-year project will review the system and control architectures and the performance requirements of multi-energy solutions currently in operation at commercial and industrial sites. It will investigate how a multi-energy approach can optimize grid power, and will assess its impact on power quality and total energy use.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on methods to optimize the system power quality and the efficient use of electric energy solution options by California industrial end users.

Proposed Outcome:

1. Technical report on the Application and Design Guidelines for a Multi-Energy Park.

Actual Outcome:

1. Application and Design Guidelines for a Multi-Energy Park Technical Report.

Project Status:

The project has been completed.

Power Quality Knowledge-Based Services

Contract #: 500-02-028 **Project #:** 10

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$30,000

Contractor Project Manager: Marsha Grossman (650) 855-2899

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The Power Quality Knowledge-Based Services program provides the essential information and resource tools needed to help Commission Staff understand the economic losses, industrial process impacts and other factors that power quality disturbances cause California Industrial and Agricultural end users. The program offers a comprehensive collection of technical and informational publications and products, educational forums, technical support, and Web-based services to enable electric power service providers to more cost-effectively and efficiently deal with today's power quality issues, planning, mitigation, and prevention.

The program provides four electronically distributed newsletters "Signature, Current Connections, TechWatch and PQNews" which regularly provide the latest information on power quality business, technical trends, educational opportunities, and project updates. A power quality case study library is available to Commission staff and other EPRI funding members to reference when desired.

The Power Quality Knowledge-Based Services Program also provides the Commission Staff access to special projects technical reports designed to help build a knowledge base of the latest power quality information, tools, products, and expert insights into power quality, provide late-breaking news on emerging power quality technologies and market trends.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on methods to optimize the system power quality and increase the efficiency of the utility network.

Proposed Outcomes:

1. An annual subscription to EPRI's *Signature* newsletter.
2. An annual subscription to EPRI's *PQ News* newsletter.
3. An annual subscription to EPRI's *Current Connections* newsletter.
4. An annual subscription to EPRI's *TechWatch* newsletter.
5. An annual subscription to EPRI's Power Quality area on EPRIweb.

Actual Outcome:

All subscription services received.

Project Status:

The project has been completed.

Power Quality Performance-Based Rate Design

Contract #: 500-02-028 **Project #:** 8

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$24,570

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

This program offers expert guidance to the Commission Staff on optimizing system power quality, while also addressing the challenges of maintaining transmission and distribution assets, meeting the power reliability requirements of the digital economy, maximizing California business opportunities by accurately assessing risk and staying abreast of relevant regulatory developments impacting the industrial end user. The project will develop design criteria for power quality indices that can be applied in a performance-based rate structure. It will develop methodologies for establishing a power quality baseline, a compliance monitoring system, and business incentives that provide a justifiable return on investments in power quality improvements. The program addresses the escalating demands of competitive markets in terms of grid scale, transactional complexity, and power quality.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidelines on methods to optimize the system power quality and minimize utility network disruptions.

Proposed Outcome:

1. Technical Report on the Technical Guidelines and Methodology for Power Quality Performance-Based Rate Design.

Actual Outcome:

1. Technical Report on the Technical Guidelines and Methodology for Power Quality Performance-Based Rate Design.

Project Status:

The project has been completed.

Voltage Sag Prediction Model Using Distribution Power Quality Phase II Data

Contract #: 500-02-028 **Project #:** 9

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$16,380

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

This project offers expert guidance to the Commission Staff on acceptable and technically feasible solutions for optimizing power quality, while also addressing the challenges of maintaining transmission and distribution assets, meeting the power reliability requirements of the digital economy, maximizing business opportunities by accurately assessing risk, and staying abreast of relevant regulatory developments. EPRI's Distribution Power Quality (DPQ) Phase II effort in 2002 resulted in a database of voltage sag information at numerous customer sites, including transmission, distribution, and secondary networks. The project will use data from DPQ Phase II to identify the correlation of customer site variables to voltage sag rate, using statistical techniques to evaluate correlation coefficients for each variable. From this analysis, it will choose a set of site descriptors and develop a linear sag predictor model using a multiple regression analysis technique. The program addresses the escalating demands of competitive markets in terms of grid scale, transactional complexity, and power quality.

This project supports the PIER Program objective of:

- Optimize Energy Conservation & Resource Efficiency by providing guidance on methods to optimize the system power quality and minimize utility network disruptions.

Proposed Outcome:

1. Technical Report on the Voltage Sag Prediction Model Using Distribution Power Quality Phase II Data.

Actual Outcome:

1. Technical Report on the Voltage Sag Prediction Model Using Distribution Power Quality Phase II Data.

Project Status:

The project has been completed.

IAW Projects Completed in 2002

Agriculture and Food Technology Alliance (AFTA) - Program 13

Contract #: 500-00-023 **Project #:** 38-39

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Global Energy Partners, LLC

Project amount: \$30,000

Contractor Project Manager: Keith Carns (559) 642-2082

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this program is to provide information and guidance to help energy companies, production agriculture operations, and food processors meet the demand for a safe and adequate food supply while meeting the newly mandated rules of the Clean Air and Clean Water Acts. Projects focus on food safety, energy efficiency, and environmentally sound processes for solid and liquid waste disposal. All projects have direct applicability or are tied to processes used extensively in California agricultural production and food processing.

AFTA offers technical assistance and customer support in all areas of agricultural production and food processing. The alliance's base of knowledge and expertise may be applied to diverse areas such as animal waste management, aquaculture, membrane and other concentration technologies for treating food production and food processing wastewater streams, food safety and regulatory issues, crop production, and handling and irrigation technologies. AFTA holds joint meetings and workshops for customers, with topics ranging from ozone usage for both agriculture and food processing, to biofuels, membrane technologies, flocculation methodologies, and legislative and regulatory concerns. These meetings allow customers the opportunity to network, discuss customers' needs and provide solutions, and evaluate and discuss future projects and programs. By having available communication tools for common or reoccurring problems, the program can often solve problems before they begin. AFTA staff also tracks emerging technologies in the Agri-Food industry and makes the findings available to program participants.

This project supports the PIER Program objectives of:

- Improving the environment, public health and safety by providing information on electrotechnologies that help California food producers and processors ensure a safe and adequate food supply.
- Providing environmentally sound electricity by expanding the use of electrotechnologies that replace or supplement processes that may harm the environment.

Proposed Outcomes:

1. Develop an Agri-Food Processing and Production Technology Solution Package for the Commission that is tailored to the needs of the California agriculture and food processing industries. The solution package may include consulting meetings between AFTA and Commission representatives, as well as the delivery of technical reports, agri-food news updates, and other information products.
2. Provide a window on news and developments in the agri-food sector by monitoring legislative, regulatory and technical publications, industry contacts and emerging technologies, and making this information available to participants in a timely manner.

Actual Outcomes:

1. Agri-Food Processing and Production Technology Solution Package.
 - Keith Carns, AFTA Director and Vice President of Global Energy Partners, paid a consulting visit to Commission headquarters and met with Pramod Kulkarni and other Commission staff to discuss California agri-food issues and potential research projects, including R&D on an advanced ethanol production process utilizing feedstock other than #2 yellow corn.
 - The following AFTA publications were published and delivered in 2002:
 - *Shelf Life and Pathogen Growth in Irradiated Sausage (1006955).*
 - *Enhancement of Food Safety (1006956).*
 - *Ozone Applications in Fish Farming (1006975).*
 - *Cumberland County College Fish Barn: An Aquaculture Education & Commercial Demonstration Facility (August 2002).*
 - *Product Concentration: an Assessment of EPRI Freeze Technologies 1985-2002 (1007399).*
 - *Treatment of Cut Vegetables with Aqueous Ozone: Technical Assessment (1007465).*
 - *Ozone Improves Processing of Fresh-Cut Produce: Tech Application (1007566).*
2. Agri-Food Technologies Window.
 - Five issues of Food Industry Currents were published in 2002. This quarterly newsletter reports on agri-food industry developments and trends. In May a special fifth edition of the newsletter was published that discussed the implications of the 2002 Farm Bill.
 - The Commission received listings of all nonproprietary AFTA publications, newsletters, Industrial News Today, e-mail alerts, meeting invitations, and hotline access to discuss problems, opportunities and potential projects with the AFTA staff.

Project Status:

The project has been completed.

Development and Demonstration of Liquid Membrane Technology for MTBE Mitigation in Aqueous Streams

Contract #: 100-98-001 **Project #:** 55

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$153,000

Match Amount: \$153,000

Contractor Project Manager: Andra Michel (650) 855-2101

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to develop and explore the economic feasibility of an advanced membrane technology—supported polymer liquid membranes (SPLM)—to reduce and remove methyl tertiary butyl ether (MTBE) contaminant in California water supplies.

The use of MTBE as a gasoline additive has generated a widespread groundwater contamination problem affecting thousands of sites in the state. Although technologies such as oxidation, air stripping, and activated carbon adsorption currently exist to remove or destroy MTBE in water, the use of a supported polymeric liquid membrane could provide an effective, practical and economical alternative. This project will investigate the properties of candidate liquid polymers, identify those most effective at removing MTBE from water, develop membrane support and module designs, conduct feasibility studies, and present results through presentations, reports, and a technology transfer seminar.

Environmental benefits include reducing and removing MTBE from California groundwater supplies, thereby improving the environment and reducing human and ecological exposure to this chemical contaminant.

This project supports the PIER Program objective of:

- Improving the value of electricity and improving the environment and public health costs/risks of California's electricity by developing an effective cleanup technology for MTBE mitigation in the environment, in effect reducing human and ecological exposure to this chemical contaminant.

Proposed Outcomes:

The project team will screen and select the best of existing liquid polymer membranes, and optimize the membrane's coating. Researchers will also design a support system for the membrane and design a prototype membrane module. Based on test data with the prototype and existing data from other treatment technologies, the team will recommend the best systems for a range of contamination situations in California.

Actual Outcomes:

Researchers reviewed existing liquid polymers based on their capabilities for optimum transport of MTBE. Silicone 350 cst (Si-350) and polybutylene glycol MW 4800 (PBG) were found to be the two best polymers because they are non-toxic, have extremely low solubility in water, and have been shown to be stable as supported liquid membranes in contact with pure water.

The researchers then optimized the coating of the best polymers to improve its transport rate and stability. Tests at Spectrum Laboratories showed that pure PBG coating method works well as

long as sufficient excess polymer is used to ensure a complete coating, or an improved procedure is developed.

The team designed a hollow fiber support system for the membrane and designed a prototype large-area, hollow-fiber module. For the support system, the team selected a standard off-the-shelf Polysulfone hollow fiber membrane with a molecular weight cut-off of 400 kD for the liquid membrane scaffolding. This pore size has proven successful in holding the polymer in place for the selective extraction of the MTBE. Regarding the design of membrane modules, Spectrum chose an axial winding pattern, consisting of sixteen parallel hollow fibers wound around a perforated core. Laboratory pilot testing was completed in 2000.

In 2001, Spectrum completed the design of a radial dispersion 35-ft² module. All components were delivered to a subcontractor for the assembly of the modules with the new winding geometry. Spectrum assembled the units in three lots of 10 modules, for independent testing at the University of California, Santa Barbara (UCSB).

Dr. Arturo Keller at UCSB tested modules. There were some issues related to the type of winding – certain geometries did not allow for the proper adhesion of Si-350, and therefore did not perform well. Spectrum corrected these problems, and supplied the correct type of modules for full testing at UCSB. The results of tests at UCSB indicate that MTBE can be readily removed from the solution using these membranes. From a technical viewpoint, the membranes performed very well in the testing.

From an economic viewpoint, given the relatively short expected life of the membranes (one to three years), the overall cost of treating water contaminated with MTBE using these membranes is currently estimated to be 6-10 times higher than other treatment processes such as granular activated carbon (GAC) or air stripping. Alternatively, the life of the membrane would have to increase to more than 20 years to result in a cost competitive process.

As a result, further research is warranted to determine whether these barriers can be overcome. Specific research issues to address are:

- Improve the flow of water through the membranes to make full use of the membrane surface area, which will significantly improve overall MTBE mass transfer to the gas phase.
- Develop a less expensive membrane.
- Determine the life expectancy of the membranes under accelerated test conditions.

EPRI completed a final report - *Development of Supported Polymeric Liquid Membrane Technology for Aqueous MTBE Mitigation* (1006577) - in November, 2002. A technology transfer seminar was held in February 2002.

Project Status:

The project has been completed.

Electrotechnology Application for Potable Water Production & Protection of the Environment

Contract #: 500-97-044

Contractor: Edison Technology Solutions/Southern California Edison

Subcontractors: Metropolitan Water District of Southern California : Orange County Water District : University of California, Riverside : Innovatech Corp. : Utility Technology Associates : Electric Power Research Institute (EPRI)

Contract Amount: \$2,889,678

Match Amount: \$13,936,267

Contractor Project Manager: Lory Larson (626) 812-7161

Commission Contract Manager: Wendell Bakken (916) 654-4042

Status: Completed

Project Description:

The purpose of this project was to develop electrotechnologies that can produce new supplies of reliable and affordable drinking water, reduce electrical use to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes. Six innovative electrotechnology-based water treatment processes were evaluated and eight specific tasks were developed to address the study objectives, which are:

1. Advanced oxidation processes.
2. Biological de-nitrification.
3. Solids removal technologies.
4. Salinity removal technologies.
5. Disinfection alternatives.
6. Solid processing techniques.
7. Energy and process assessment.
8. Technology transfer and process scale-up for commercial deployment.

This project supports the PIER Program objective of:

- Improving the environmental and public health costs/risks of California's electricity by avoiding electricity use and costs to transport water over long distances and by avoiding investments in long-distance water transfer projects.

Proposed Outcomes:

1. Evaluate two advanced oxidation processes: pulsed UV/hydrogen peroxide and ozone/hydrogen peroxide, for their effectiveness in removing methyl tertiary butyl ether (MTBE), perchlorate, and other synthetic compounds from surface water and groundwater supplies.
2. Demonstrate how biological denitrification helps reduce concentrations of nitrate in contaminated wells to acceptable limits so that these wells can be re-activated as drinking water sources.
3. Evaluate the performance of solids removal technologies for surface water, municipal wastewater, and agricultural drainage water as a pretreatment for salinity removal processes.
4. Evaluate the effectiveness of two, non-thermal desalination technologies for the demineralization of surface water, reclaimed water, and agricultural drainage water. The non-thermal desalination technologies to be evaluated are experimental membranes (reverse osmosis (RO) and nanofiltration (NF) membranes) and carbon aerogel capacitive deionization (CDI).

5. Evaluate the effectiveness of pulsed-UV irradiation and ozone as physical, post-filtration disinfection processes for the inactivation of viruses, bacteria, and protozoa.
6. Investigate the effectiveness of mechanical freeze-thaw conditioning to enhance the dewatering of waste-stream residuals (sludge) from both conventional and desalting water treatment processes.
7. Conduct energy assessments of municipal water and wastewater unit processes to determine their energy use and water quality processing characteristics and to identify areas for improvement through application of electrotechnologies.
8. Evaluate preliminary scale-up issues for pulsed-UV irradiation, microfiltration for solids removal and desalting membranes. More specifically, a larger pulsed-UV treatment chamber, a demonstration MF system, and new, large diameter reverse osmosis membrane elements will be designed and tested for large-scale water and wastewater applications.
9. Connect the results from the electrotechnology research conducted through this contract to the research and water utility industry which can apply the results to their own research and which can adopt the technologies into their water-utility operations.

Actual Outcomes:

1. Investigate Advanced oxidation Processes:
 - Objective: Study the effectiveness of Pulse UV for the reduction of bromate, MTBE, NDMA, perchlorate, and taste & odor.
 - Outcomes:
 - 1) Bromate reduction by Pulsed UV – no significant reduction in bromate at UV doses less than 100 mJ/cm². When compared to the UV for 1-log₁₀ inactivation of Cryptosporidium, Pulsed UV takes almost 1000 times UV dose for the same reduction of bromate.
 - 2) MTBE reduction by Pulsed UV and ozone/peroxide – without H₂O₂, a high UV dose (47,000 mJ/cm²) reduced MTBE by 87 percent adding 69 mg/L H₂O₂ lowered the required dose to 1600 mJ/cm². These UV and H₂O₂ doses, however, are prohibitive in drinking water applications. At high MTBE concentration (2000mg/L), Ozone/peroxide (PEROXONE) removed substantially more MBTE than ozone alone. However, at the lower MBTE concentration (200 mg/L), ozone and PEROXONE performed similarly.
 - 3) NDMA treatment by Pulsed UV and ozone/peroxide – H₂O₂ addition did not improve NDMA removal. However, water quality parameters such as nitrate and turbidity presence could affect NDMA removal. Reduction of NDMA by ozone (at 5 mg/L) was minimal but was much greater (50%) with PEROXONE at the same concentration.
 - 4) Perchlorate reduction by Pulsed UV – no measurable perchlorate reduction was observed because perchlorate does not absorb UV light.
 - 5) Taste and odor reduction by Pulsed UV –Without H₂O₂, 10,100 mJ/cm² applied UV (very high) dose was needed to reduce MIB and geosmin by 92 and 97 percent respectively. Adding 5.5 mg/L of H₂O₂, only 1,100 mJ/cm² was needed to achieve comparable results.
 - Conclusions:
 - 1) Bromate reduction by Pulsed UV.
 - Bromate reduction was more efficient in laboratory waters (89 %) than natural waters (18%) for UV dose of 3,100 mJ/cm² and 4,000 mJ/cm² respectively.
 - 2a) MTBE reduction by Pulsed UV.
 - UV alone cannot effectively reduce MTBE.

- UV/H₂O₂ is effective in reducing MTBE.
 - H₂O₂ dose strongly affects efficiency of MTBE reduction.
- 2b) MTBE reduction by Ozone and PEROXONE.
- PEROXONE was more effective in oxidizing MTBE than ozone, particularly when water contained higher MTBE concentrations.
 - Ozone doses of 19 mg/L (with 47 mg/L H₂O₂) and 24 mg/L (with 30 mg/L H₂O₂) were needed to meet the secondary standard of 5 µg/L for 200 and 2,000 mg/L of MTBE, respectively.
 - MTBE by-products such as TBF, TBA, acetone, and aldehydes were identified to have hindered MTBE removal efficiency.
- 3a) NDMA Reduction by Pulsed UV.
- UV alone is effective in removing NDMA.
 - Characteristics of water type played an important role for NDMA reduction.
 - NDMA removal was affected by a strong competition for UV light absorption between NDMA and background organics (e.g., TOC and UV₂₅₄-absorbing organics) and nitrate.
- 3b) NDMA reduction by Ozone and PEROXONE.
- Ozone alone is ineffective in NDMA reduction in drinking water.
 - PEROXONE improved NDMA removal efficiency compared to ozone alone.
- 4) Perchlorate reduction by Pulsed UV.
- Perchlorate was not reduced by UV.
 - Perchlorate concentration, H₂O₂ dose and pH had no effect on perchlorate reduction.
- 5) Taste-and-Odor Compounds.
- A UV dose of 10,100 mJ/cm² reduced MIB and geosmin by 92 and 97 percent, respectively.
 - 100 mJ/cm² (a disinfection-level UV dose) and 5 mg/L H₂O₂ provided 86 and 96 percent reduction of MIB and geosmin, respectively.
- Recommendations: Based on water quality issues and cost requirements, one of the technologies evaluated here could be applied for reduction of water contaminants. Although ozone may be significantly less energy-intensive than UV for several of the micropollutants studied, UV may be a more appropriate option based on DBP formation potential. In considering these technologies, utilities must weigh energy and DBP costs prior to implementation.
 - Benefits to California: It is beneficial for California utilities to understand the limitations of advanced treatment techniques before implementation. As UV light may provide excellent disinfection efficiency and low DBP formation at disinfection-level dosages, high-energy requirements for micropollutants treatment may cause water utilities to consider ozone. Utilities must, however, consider the level of DBPs that high ozone dosages may produce.
2. Biological Denitrification.
- Objectives:
 1. Demonstrate the technically and economically viability of biological denitrification.
 2. Obtain California DHS approval for the BioDen™ system as a viable treatment system for nitrate removal and potable water production.
 3. Demonstrate ceramic filtration is a viable post treatment for biological denitrification.

4. Determine O&M costs for biological denitrification unit using hollow fiber microfilter, including power consumption and methods to reduce power requirements.
- Outcomes: In 1995, the City of Modesto purchased the Grayson water system from Del Este. The water supply is valuable to the City, but the water is contaminated with excess nitrates. The City was interested in assessing biological denitrification as a low-cost option to the more conventional treatment possibilities. Significant progress was made in implementing the demonstration project described in this report. However, at the end of 2000 the City decided to delay the commercial demonstration project in favor of drilling a new 1,000 feet deep well to obtain water with nitrates below the regulatory action level. EPRI and the researchers would like to see the demonstration project be launched in the next 3 to 6 months.
 - Conclusions:
 1. On December 20, 2000, the City of Modesto officially notified the researchers at Nitrate Removal Technology of its decision to postpone the Grayson Biological Denitrification Project. Instead, the City would install a 1,000 feet deep well in the area of the Grayson system to obtain water with nitrate below the government action level. The City staff was extremely reluctant to use microbes to accomplish a potable water treatment goal, even with post disinfection of the effluent. This potential health concern was the roadblock that must be overcome before the technology can be commercialized.
 2. While EPRI and the researchers were disappointed with the City's decision, the team was able to secure approval from the California Department of Health Services for a suitable test protocol for this process. As designed, the protocol will yield valuable information for the Department to rule on the efficacy of the biological denitrification treatment system.
 3. Based on discussions with California Department of Health Services and other interested parties, the Modesto pilot study will be conducted in two phases. The first phase will consist of a one to three-month demonstration of a 6 to 10 gpm pilot system to evaluate water quality, denitrification achieved, and the impact on filtration. During Phase 2 of the study, a demonstration system capable of treating 300 gpm or more will be installed and operated to develop detailed cost data on the process. Preliminary estimates suggest that biological denitrification compares quite favorably to both ion exchange and reverse osmosis, which are the two technologies used to remove nitrates today.
 - Recommendations: Biological denitrification should be further pursued for nitrate removal and reactivation of contaminated shut-in wells. Commercial demonstration and public awareness should be the continuing focus of this technology. Biological denitrification are estimated to be equal to or less than conventional treatment options such as ion exchange and reverse osmosis. The broad range in costs for the conventional treatment technologies (\$0.55 to \$ 5.20 per thousand gallons treated) is the result of brine disposal costs and electricity costs, which vary depending on the location. In California, these disposal costs and power costs are expected to be on the high side of these ranges. Recent California's power shortage issues may limit the application of ion exchange and reverse osmosis from near-term commercial deployment.
 - Benefits to California: Given the tremendous difficulties of removing nitrate from potable water supplies using conventional treatment processes, biological denitrification is a potentially attractive alternative. This innovative process can significantly reduce disposal concerns as well as permitting and infrastructure

buildups. Reactivation of shut-in wells due to nitrate contamination can be a viable source of supply water both for local communities and new developments.

3a. Solids Removal Technologies MWD Study.

- Objectives:
 1. Evaluate pilot-scale conventional treatment with and without ozone/ biofiltration, and microfiltration processes as the pretreatment step to RO desalting.
 2. Evaluate full-scale conventional treatment as the pretreatment step to RO desalting.
 3. Model the cost savings associated with a 100 mgd desalting plant using conventional treatment (both with and without ozone and biologically active filters) versus microfiltration as the pretreatment step.
- Outcomes:

Pilot-Scale Testing.

 1. Microfiltration produced water containing lower particle counts, turbidity, and silt density index (SDI) than either conventional treatment or conventional treatment with ozone/biofiltration.
 2. Pretreatment using conventional treatment showed the poorest RO performance in terms of maintaining stable flux over time, followed by conventional treatment with ozone/biofiltration, and finally microfiltration. Salt rejection of the membranes for all three pretreatment technologies ranged from 97 to 99 percent.
- Outcomes:

Full-Scale Testing With Aluminum Sulfate.

 1. Five different RO membranes were tested using alum coagulation and chloramines. Results revealed rapid deterioration in specific flux as well as progressive reductions in salt rejection with Ferric Chloride.
 2. Instead of declining as in alum coagulation, the specific flux using ferric chloride and chloramines increased over time for all membranes. However, salt rejection for each membrane decreased significantly during testing.
 3. Preliminary cost estimates showed that existing conventional treatment plant was the lowest cost option (\$0.39/1000 gal of finished water). MF showed 10 percent higher cost (\$0.44/1000 gal) due to additional pretreatment facilities needed. The addition of ozone and biological filtration lowered the RO capital costs, but increased the overall treatment costs to \$0.52/1000 gal, due to need for new pretreatment equipment.
- Conclusion:

Pilot-Scale Results.

 1. Microfiltration provided the highest quality and lowest cleaning frequency water to the RO process. Conventional treatment required chemical cleaning three times in three-month test period due to organic and biological fouling. Performance was improved with the addition of pre-ozonation and biologically-active filters.
- Conclusion:

Full-scale Results.

 1. Testing with full-scale conventional drinking water treatment showed differing results. Conventional treatment using both aluminum sulfate and ferric chloride coagulation showed adverse membrane performance which could hinder full-scale RO implementation. However, salt rejection was largely unaffected.

2. The addition of either ozone and biological filtration or MF lowered the RO capital costs, but increased the overall treatment costs due to the need for new pretreatment equipment.
 - Recommendations:
 1. Additional applied research is needed to optimize the conventional treatment process with and without ozone/biofiltration. A better understanding of the improved performance under the ozone/biofiltration pretreatment and its effects on the NOM of the water are needed. Additional work is also needed to better understand the full effects of interaction of different chemicals such as: coagulants (i.e. ferric, alum), disinfectants (i.e. chloramines), and antiscalants on the surface of the membrane.
 2. Microfiltration is the optimal pretreatment technology to provide the best feed-water for RO membranes with minimum fouling. However, additional work with conventional treatment processes may help water treatment plants use existing infrastructure as pretreatment to RO, thereby saving capital costs.
 - Benefits to California: Study results will enable local municipalities to adopt desalination technologies to treat current and previously unusable potable water supplies. Economic benefit is the reduction of societal damages to the public and private sectors due to high salinity of the Colorado River water (CRW). An additional benefit is the reduction of energy needed to reduce TDS of the CRW over currently available technologies. Technologies evaluated in this task may also be applicable to other source waters in California.
- 3b. Solids Removal Technologies OCWD Study.
- Objectives:
 1. Investigate microporous membrane module potting technique, membrane symmetry, fiber modulus of elasticity, fiber thickness, module flow pattern (inside-out or outside-in), and membrane material.
 2. Develop mathematical modeling using structure-fluid interactions with analysis of membrane failure made to test performance at OCWD pilot- and demonstration-scale facilities.
 - Outcomes: SEMs images were created for the five membrane fibers. Tensile testing results of the hollow fiber membranes was performed. A structural and a fluid model of a dynamically potted module with an elastomer overlay were developed using the symmetry, thickness, and strength data.
 - Conclusions: Correlations between membrane and module properties and membrane fiber failure (i.e., loss of integrity) were difficult to make because only two membrane fibers (the PM100s and PVDF fibers) underwent both materials testing and performance testing. Preliminary modeling results found the existence of additional stresses at the fiber/potting juncture which might possibly lead to the formation of fractures.
 - Recommendations: Future efforts should include evaluations of immersed hollow fiber membranes and the impact of backwashing (using both air and water) on hollow fiber membrane integrity. The current model for pressure-driven membranes could be modified to evaluate suction-driven membranes or to evaluate the effects of air and water backwashing. Similar to the current investigation, results from the modified structure-fluid model would be combined with analysis of membrane failure for OCWD membrane systems.
 - Benefits to California: Preventing microporous fiber breakage will have a significant effect on water treatment and wastewater reclamation in California and throughout

the world. The performance of reverse osmosis membranes in indirect potable reuse and the efficacy of disinfection processes (chlorination and ultraviolet irradiation) in direct non-potable reuse are directly dependent on MF and UF fiber integrity.

4a. Salinity Removal Technologies MWD Study.

- Objectives:
 1. Investigate the performance of experimental RO membranes and NF membranes.
 2. Evaluate long-term fouling rate of RO membranes using conventionally pretreated water.
 3. Determine potential cost savings using experimental membrane flux and salt rejection data.
 4. Evaluate various commercial and generic antiscalants to prevent scale formation during RO treatment of Colorado River water.
- Project Outcomes:
 1. Of the five RO membranes evaluated, RO1 (Dow Separation Processes, FilmTec Enhanced LE) provided the highest specific flux (0.37 gfd/psi) while still maintaining high salt rejection (98.8 percent). Performance data for NF membranes provided a wider range of variation in water production and salt rejection properties than RO membranes. NF membrane NF1 (Dow Separation Processes, FilmTec NF90) showed comparable specific flux and salt rejection to that of RO1.
 2. Ion hydrated radius and solution pH had a direct impact on the salt rejection behavior of NF membranes. Generally, as the hydrated radius increased (e.g., from sodium to sulfate), the rejection of that ion also increased. Additionally, operation at low pH conditions increased NF membrane salt rejection through chemically tightening of the membrane surface.
 3. All four experimental RO membranes have overall membrane system costs at least 15 percent lower than commercially available RO membranes. Two of the NF membranes tested demonstrated superior performance in specific flux and salt rejection over a current commercially available ultra-low-pressure RO membrane, resulting in 19 and 14 % cost savings, respectively.
- Conclusions:
 1. With the development of polyamide membranes, not only has the operating pressures for membrane systems decreased, but the water production per psi has also increased substantially.
 2. NF membranes operate at significantly higher flux rates than RO membranes, but exhibit poorer salt rejection.
 3. Closed-loop membrane testing, while inexpensive, may not provide representative water quality conditions and single-pass, multi-array membrane systems are not only expensive but have high water flow rate demands (up to 20 gpm).
- Recommendations:
 1. Further research is needed to wed the high water production of NF membranes with the high salt rejection of RO membranes. Next generation membranes that are either chlorine tolerant to prevent biofouling or exhibit unique surface charge characteristics to prevent particle and bacterial adhesion, or even scaling should also be developed.
 2. Smaller, single-pass membrane test systems need to be developed.
 3. A standardized protocol needs to be developed for interpreting RO membrane and water quality data to judge antiscalant effectiveness.

- Benefits to California:
 1. Results from this study will enable local municipalities to adopt desalination technologies to treat currently and previously unusable potable water supplies.
 2. The primary economic benefit is the reduction of societal damages to the public and private sectors due to high salinity of Colorado River water. An additional benefit is the reduction of energy usage to reduce the TDS of CRW over currently available technologies.
- 4b. Salinity Removal Technologies OCWD Study.
 - Objectives: The objectives of this research were to study RO membranes' performance for salinity removal using different materials as well as feed sources. Part of research also examined treatment methods and options for the brine concentrate generated from the process. Specifically the objectives address:
 - 1) Studying and developing new RO membranes that are resistant to chlorine.
 - 2) Investigating nitrification and denitrification of RO brine (waste).
 - 3) Testing the RO and MF processes on the wastewater treatment side.
 - Outcomes:
 - A. Chlorine Tolerant Membranes.
 1. Chlorine tolerant membrane performance was found to be equal, or superior to traditional commercial RO membranes.
 2. Water quality was comparable while the total product water production was generally greater than the commercial membranes. The rate at which water production (or flux) declined was also lower than the commercial membranes.
 3. Commercial TFC membranes in the marketplace lack chemical tolerance to such oxidants as chlorine.
 - B. Brine Disposal.
 1. The FBBR-GAC system has proven very efficient both in terms of process and energy consumption for the denitrification and sulfate reduction of brine concentrates. The optimum operating parameters were determined in this research.
 2. Preliminary laboratory-scale experiments revealed that the FBBR-GAC process is capable of removing approximately 45% of sulfate and 100% nitrate.
 - C. IMANSTM.
 1. Initial testing of the IMANSTM process for wastewater treatment combined with water reclamation has shown promising results in sustainable performance and cost effectiveness.
 2. Potential capital cost and significant O&M cost savings are predicted for an IMANSTM approach compared with the conventional membrane approach for treatment of secondary wastewater effluent.
 3. This established the technical feasibility of the IMANSTM process combination, even under challenging test conditions such as use of a six-year-old MF pilot.
 - Conclusions and Recommendations.
 - A. Chlorine Tolerant Membranes.
 1. Conclusions:
 - CPTC membrane was equal or superior to traditional commercial membranes for long-term performance.

- CPTC membrane looks promising as a membrane that could successfully treat high fouling water sources without compromising membrane integrity and performance due to fouling and chemical degradation.
 - 2. Recommendations:
 - The successful development and widespread implementation of a new polymer membrane is a timely process.
 - More testing will be required to determine the practicability of this membrane as an alternative to conventional TFC membranes in treating high fouling water and wastewater sources.
 - 3. Benefits to California:
 - The use of highly efficient, low fouling membranes would ultimately increase product water throughput while minimizing associated treatment costs.
 - TFC polyamide membranes operate at lower operating pressures than cellulose acetate membranes, which can translate into significant energy savings of 30% to 40%. Using a lower pressure TFC membrane that exhibits fouling resistance would further reduce energy costs.
 - Less biofilm proliferation and accumulation on the membrane surface would result in lower operating pressures and subsequently lower energy costs.
- B. Brine Disposal.
- 1. Conclusions:
 - The optimum temperature range for the denitrification was determined to be between 20°C and 40°C.
 - The total dissolved solid (TDS) concentration had insignificant effect on the denitrification rate.
 - Preliminary laboratory-scale experiments revealed that the FBBR-GAC process is capable of removing approximately 45% of sulfate and 100% nitrate.
 - 2. Recommendations:
 - The FBBR-GAC process needs to be further investigated in laboratory and pilot scales relative to energy efficiency and cost-effectiveness.
 - More investigation is needed to upgrade the system for better sulfate removal.
 - A model and detailed experimentations need to be developed for biological removal in dual-substrate systems (nitrate and sulfate).
 - 3. Benefits to California:
 - Water recycling is foreseen as one of the best alternatives to meet the ever-increasing water demand in Southern California. It is through recycled water that the depleted groundwaters are replenished, saline water intrusion from the ocean is prevented, and surface water supplies are augmented.
 - The Fluidized Bed Biofilm Reactor with Granular Activated Carbon technology has been proven to be very effective in the treatment of the RO brine concentrates. One notable advantage of fluidized bed reactors is that they require minimal space, and is relatively small as compared to conventional systems because of excessive biomass growth.
 - The reaction time is short and the treatment efficiency is high, making it easily adoptable by the utilities planning to employ the RO technology to recycle water in residential areas where land availability is scarce or limited.

C. IMANSTM

1. Conclusions:

- The initial testing of the IMANSTM process approach for wastewater treatment combined with water reclamation has shown promising results in terms of sustainable performance and cost effectiveness.
- Potential capital cost savings and significant O&M cost savings are predicted for an IMANSTM approach compared with the conventional approach of using membranes to treat secondary wastewater effluent.
- Elimination of the secondary wastewater treatment step, lower life cycle costs, 50 percent less solids production, and smaller plant footprint, all establish the potential benefits of this new approach to wastewater treatment and reclamation using membrane filtration on primary wastewater effluent.

2. Recommendations:

- Research is needed to study how other configurations of MF units could treat primary effluent.
- It is equally important to establish communication with the regulatory agencies to discuss possible alternatives for reuse and discharge prior to commercial development.

3. Benefits to California: This research and demonstration testing could significantly alter the manner in which wastewater agencies discharge waste effluent into the ocean or any other water body. By evaluating the microfiltration process as a means of disposing primary effluent, alternate methods can help better manage waste discharges.

5a. Investigate Disinfection Alternatives MWD Study.

• Objectives:

1. Evaluate ability of heterotrophic bacteria to repair or regrow following UV treatment.
2. Compare disinfection effectiveness of pulsed UV and medium-pressure UV lamps against single-stranded RNA virus MS-2.
3. Evaluate disinfection effectiveness of UV lamps against two organisms, phi-6 and *Bacillus subtilis*.
4. Determine ability of *Cryptosporidium parvum* to self-repair infectivity after exposure to UV light.
5. Determine disinfection effectiveness of UV light against *Giardia lamblia*, protozoan pathogen found in drinking water.

• Outcomes:

1. UV light at 20 mJ/cm² produces equivalent effect on heterotrophic bacteria as chlorine (1 minute contact) and chloramines (61 minutes contact). The three treatment techniques each provided more than 3.5 log₁₀ inactivation of bacteria.
2. UV was effective in disinfecting three organisms: *B. subtilis* aerobic spores, MS-2 coliphage, and phi-6 bacteriophage, with a dose of 40 mJ/cm² providing 1.9, 1.5, and 2.0 log₁₀ inactivation, respectively.
3. Study results found that a very low UV dose of 1.4 mJ/cm² would provide a 2 log₁₀ inactivation of *G. lamblia*.
4. Experiments were conducted to determine if a conventional medium-pressure UV lamp and a pulsed-UV lamp could effectively inactivate heterotrophic bacteria, *B. subtilis*, MS-2, phi-6, and *C. parvum*. Across all the experiments for disinfection, there appears to be no significant difference in the results obtained when using one lamp or the other.

5. This study also evaluated the effects of UV only, compared with the effects of UV followed by addition of chloramines, on the biological stability of treated samples. Study results showed that regrowth occurs within a 3-day period with UV dose alone of up to 60 mJ/cm². However, when treated with 20 mJ/cm² UV dose followed by a chloramine dose of 2.6 mg/L, the samples remained biologically stable for at least 7 days.
- Conclusions:
 1. The protozoa and heterotrophic bacteria were more susceptible to UV light, with dosages of less than 20 mJ/cm² providing 2 log₁₀ inactivation. Organisms more resistant to UV light were the double-stranded RNA virus phi-6, followed by B. subtilis and then the single stranded RNA virus MS-2. For these organisms, a UV dose between 40 and 53 mJ/cm² was required to provide 2 log₁₀ inactivation. The disinfection provided by UV on the human pathogen G. lamblia was even more effective than previously reported for G. muris, a more easily handled rodent parasite.
 2. This task study shows that the process of using UV light to control post-filtration heterotrophic bacteria would need to be followed by a residual disinfectant such as chlorine or chloramines to provide a water with biological stability.
 3. The disinfection provided by either a medium-pressure, continuous-wave UV lamp or an innovative pulsed-UV lamp was similar when compared, on an equivalent UV dose basis. Both lamps were effective in the treatment of C. parvum, but it could not be determined whether or not C. parvum could repair itself following UV treatment.
 - Recommendations:
 1. Future studies should determine if C. parvum repair mechanisms may exist after UV treatment.
 2. To better quantify effects of organism repair in future studies, it would be beneficial to wait until improvements in C. parvum infectivity assays are made to reduce variability.
 3. Future research must complement the bench-scale data by evaluating the process efficiency and hydraulic characteristics of large-scale UV reactors.
 - Benefits to California: UV disinfection is fast becoming a great benefit to California water treatment utilities. However, recommendations stated above should be followed before implementing large-scale UV technology. Although the process shows to be viable at the bench-scale, large-scale application for on-line monitoring are still in development and should be evaluated before implementing the technology as a reliable barrier to waterborne human disease and illness.
- 5b. Investigate Disinfection Alternatives OCWD Study (Disinfection Alternatives).
- Objectives:
 1. Evaluate the low-pressure high-intensity open channel UV system to demonstrate compliance with the California Reclamation Criteria" and to meet Title 22 standards.
 2. Determine the efficiency of UV disinfection for inactivation of protozoa.
 3. Establish dose curve for pulsed UV and compare the performance of pulsed UV for disinfection of microorganisms using various water matrices.
 - Project Outcomes:
 1. Evaluation of Wedeco-Ideal Horizons TAK 55 System – The TAK 55 system was found to be most effective when used with three banks in series and when the flow rate was limited to 17 gpm / lamp. The system proved to be successful

in meeting the criteria established by State of California Title 22 Wastewater Reclamation Criteria.

2. Efficiency of UV for Protozoa Inactivation – The use of collimated beam apparatus proved that UV is effective for inactivation of protozoa species including *Giardia muris* and *Bacillus subtilus*. It was found that the low pressure, high intensity collimated beam apparatus was most efficient but that all three systems were equally effective.
 3. Evaluation of Pulsed UV – The pulsed UV system was originally designed to treat surface water sources, but was shown to be successful for the disinfection of treated wastewater. The addition of a baffle system to the pulsed UV eight inch diameter treatment vessel proved to be key to the system's effectiveness.
- Conclusions:
 1. Ultraviolet disinfection is an important technology for reclamation projects.
 2. Low-pressure, high-intensity open channel UV systems were effective for meeting California's Title 22 reclamation criteria.
 3. Ultraviolet technologies of varying types: pulsed, low pressure-high intensity, and medium pressure were effective for the inactivation of protozoa.
 4. Pulsed UV technology had comparable effectiveness to conventional UV for the disinfection of various microorganisms in various water matrices.
 - Recommendations:
 1. Evaluation of Wedeco-Ideal Horizons TAK 55 System – The testing of the Wedeco-Ideal Horizons TAK 55 lamp technology has proven that this technology is viable for meeting the disinfections standards set by the California Title 22 guidelines for wastewater reclamation. It is recommended that this system be considered for use in future or current municipal reclamation projects.
 2. Efficiency of UV for Protozoa Inactivation – Tests need to be run using *G. muris* as an indicator organism for evaluation on a pilot scale UV system without having to lower the transmittance to an unreasonable level. It is also necessary to find a way to keep the *G. muris* from sticking to the plastic batch tank and the plastic PVC pipes which are connected at the influent and effluent ends of the pilot UV units.
 3. Evaluation of Pulsed UV – The next step that should occur would be to test the pulsed UV 8" diameter pilot unit on membrane treated wastewater.
 - Benefits to California:
 1. The testing could lead to certification of the Wedeco-Ideal Horizons TAK 55 technology by the California Department of Health Services for use in Title 22 reclamation applications. The certification of this technology should lead to an increase in options for agencies that are in need of disinfection technologies for reclamation projects.
 2. Completing this task has benefited California in that it shows that low levels of UV radiation are able to disinfect harmful protozoa. This allows other agencies to use UV technology in place of conventional disinfection technologies, which may be more expensive or may create unwanted disinfection byproducts.
 3. The benefits to California are that there is now documented research and pilot demonstration to show that pulsed UV technology can be applicable to disinfection for reclamation applications.

6. Investigate Solids Processing Techniques.

- Objectives:
 1. Evaluate the economics of using the BIOFREEZETM unit for conditioning water treatment plant residuals.
 2. Determine if biological wastewater residuals can obtain the same separation rate as inorganic water treatment plant residuals.
 3. Evaluate the economics of using BIOFREEZETM for conditioning wastewater residuals.
 4. Evaluate freeze concentration of reverse osmosis brine to determine if separation of salts can be achieved.
- Outcomes: The purpose of this study was to evaluate the effects of freeze-thaw technology on water and wastewater residuals. All testing took place at OCWD in Fountain Valley, CA, on specific residuals of the following types:
 1. Alum Sludge from a water treatment plant.
 - Volume Reduction -- The F/T conditioning process reduce sludge volume by an average of 16 percent, with a range of 6 to 26 %.
 - Supernatant Quality --The solids concentration of the supernatant, collected after gravity thickening for 2 hours, ranged from 650 to 930 mg/L which were higher than EPRI's previous reports ranging from 100 to 375 mg/L.
 - Gravity-Thickened Solids Concentration – The solids content of the gravity-thickened sludge ranged from 11 to 12.5 percent which were similar to previous EPRI studies.
 - Dewatering Using A Belt Filter Press – The solids concentration of gravity thickened solids dewatered on a pilot-scale belt filter press, ranged from 22.3 to 26 percent which were also similar to those reported by EPRI.
 2. Ferric Chloride Sludge from MWD's water treatment plant.
 - Volume Reduction -- The F/T conditioning reduce residuals volume by 45 to 81 percent.
 - Supernatant Quality -- The solids concentration of the supernatant, collected after gravity thickening, ranged from 930 to 1,070 mg/L.
 - Gravity-Thickened Solids Concentration -- The solids concentration of the gravity-thickened sludge had a percent solids range of 10 to 16 percent.
 - Dewatering Using Belt Press -- The solids concentration of sludge dewatered on a belt filter press ranged from 22 to 32 percent.
 3. Biological Sludge from OCWD's wastewater plant thickened activated sludge (TWAS).
 - The DAF-thickened TWAS had a solids concentration of approximately 8 percent. Unlike the inorganic sludges, the sludges subjected to F/T conditioning in this study were not reduced in volume.
 4. Brine from OCWD's wastewater plant's MF and RO treatment.
 - The freeze concentration (FC) pilot testing produced ice with TDS concentrations which ranged between 2757 and 5100 mg/L, and averaged approximately 3800 mg/L.
 - Volume Reduction -- For the FC test runs, the influent brine volume was reduced between 24 and 89.6 percent.
 - Power Requirements -- Power consumption for these test runs ranged between 3.3 and 15.1 kWh. Power consumption per ton of product frozen varied between 118.7 and 393.6 kWh per ton. For a commercial F/T system, the power consumption should range between 24 and 40 kWh/ton.

- Conclusions:
 1. Mechanical F/T is extremely effective at reducing inorganic residual volumes, achieving up to a 94% reduction.
 2. Mechanical F/T of the wastewater biological residuals collected for this study did not produce the high level of separation achieved with the inorganic sludges.
 3. FC of RO brine did produce a concentrating effect, and reduce the volume of concentrated brine for disposal. Results of the testing did not appear to achieve low concentrations of TDS in the ice (average ice TDS, 3260 mg/L expected ice TDS, 500 mg/L).
 4. Most of the power data collected during this study was inaccurate due to the BIOFREEZETM unit not being insulated.
 5. The economic analysis of the freeze/thaw method appeared to be cost competitive with conventional treatment of water residuals.
 - Recommendations:
 1. Additional demonstration testing needs to be completed to verify the results of previous testing. The testing should concentrate on the thickening step to verify the assumptions used in this report.
 2. Capital costs are a significant obstacle for application of F/T. It is recommended that additional freezing systems be evaluated to determine if the capital costs can be reduced.
 3. For the biological sludges, the BIOFREEZETM system appears to be able to provide substantial benefits to anaerobic digestion. Further testing needs to be completed to confirm that increased methane production can be achieved and to what extent dewaterability of the sludges can be expected.
 - Benefits to California: The freeze-thaw process can be used to condition the biological residual before anaerobic digestion. The benefits to California from the use this technology include:
 1. Increased methane generation capacity.
 2. Increased dewaterability of sludge.
 3. Reduce the amount of salt to be disposed in landfills from microfiltration-membrane treated wastes.
 4. Reduce the amount of salt from chemically treated wastes to be disposed by ocean discharge.
7. Perform Energy and Process Assessment.
- Objectives: To conserve energy, reduce chemical use, and improve energy efficiency by using an integrated approach to energy and process assessment at four selected municipal water and wastewater treatment facilities.
 - Outcomes: This task surveyed and summarized the findings at four water and wastewater treatment plants in California:
 1. San Francisco's Harry Tracy water treatment plant.
 2. Metropolitan Water District's Jensen filtration plant.
 3. Union Sanitary District's wastewater plant.
 4. Vallejo Sanitation and Flood Control District's wastewater plant.

Energy consumption and cost for each plant were determined based on plant flow and energy billings and demand usage. Energy conservation measures (ECMs) were developed at each plant. For the water plants, the ECMs include three lighting retrofits to improve efficiency and control, an energy management systems, load shedding three systems during peak hours, modifications to improve the equipment

efficiency of three processes, and an HVAC change to reduce cooling. For the wastewater treatment plants, the ECMs include two lighting retrofits to reduce lighting and improve control, two energy management systems, operational changes to two processes, modifications to two non-potable water systems to reduce load, equipment modifications to improve efficiency, load shedding during peak hours, changes to a cogeneration system, and a change to a discharge permit to lower demand.

- Conclusions: Eleven energy conservation measures (ECMs) at the water plants and twelve at the wastewater plants were identified through this task. These ECMs are estimated to save 8,533,854 kWh annually, which produces a cost saving of approximately \$564,580. The ECMs are summarized below:

Type of ECM	No.	Energy Savings (kWh)	Annual Cost Savings	Potential Rebates	Estimated Capital Cost	Recommended
Lighting Retrofits	5	51 kW 402,924 kWh	\$27,180	\$39,826	\$74,000	YES
Energy Management System	3	420 - 480 kW 0 kWh/yr	\$37,300		\$65,000	YES
Load Shifting	4	501 kW 58,500 kWh/yr	\$49,800	\$5,625	\$3,000	YES
Equipment Modifications	4	362 kW, 941,810 kWh/yr	\$54,800	\$114,595	\$50,250	YES
HVAC Changes	1	0 kW, 72,000 kWh/yr	\$3,700		\$2,000	YES
Operational Changes	2	75 kW 803,000 kWh	\$44,800	\$35,640	\$30,000	YES
Modify NPW System	2	19 kW 762,120 kWh	\$42,000	\$91,090	\$42,000	YES
Cogen Changes	1	600 kW 4,600,000 kWh	\$254,000	\$180,000	\$205,000	YES
Permit Changes	1	127 kW 893,500 kWh	\$51,000	\$80,415	\$150,000	YES
Total of Recommended ECMs			\$564,580	\$547,191	\$621,250	

- Recommendations: It is recommended to implement the ECMs identified in this project and to conduct new studies at other facilities throughout the state to further reduce electrical demand and conserve our natural resources.
- Benefits to California: The State of California benefits by the significant energy savings, conservation of natural resources, reduction in pollution, minimized costs, and improved quality of treatment which thereby protects the environment.

8. Scale-up Issues MWD Study.

- Objectives:
 1. Evaluate preliminary scale-up issues by assessing operational and water quality needs that impact design criteria for construction of a large-scale UV systems.

2. Conduct biosimetry challenges to characterize performance in terms of transferred UV dose (UV dose measured at the bench-scale).
 3. Monitor UV reactor over a period of testing to evaluate process performance.
 4. Determine the element productivity, ion selectivity, fouling potential, and cleaning cycle of a 16-in. and an 8-in.-diameter RO elements.
 5. Perform economic analysis of a full-scale RO plant utilizing 8-in. versus 16-in. diameter elements.
- Outcomes:
 1. It is possible to increase the output of a MF module by increasing the surface area without increasing the module cleaning requirement.
 2. Adequate contact time during pre-chlorination is essential for the control of microbial fouling of the membrane surface.
 3. The overall process recovery of the full-scale Pall microfiltration system was found to be 90% at a flux of 24 gallons per square foot per day and a backwash interval of 15 minutes.
 4. The optimum cleaning procedure involved a caustic cleaning with a 2% sodium hydroxide solution and 5000 ppm chlorine followed by an acid cleaning using a 2% citric acid solution.
 5. The amount of energy required by the full-scale Pall microfiltration system is 400 kWh per million gallons of water treated.
 6. It is possible to operate a full scale system with some exposure to direct sunlight. Over the course of a year and a half, no deterioration was found on either the coated or the uncoated modules.
 - Conclusions:
 1. To meet the requirement established by OCWD for a three-week interval between chemical cleanings, an ideal process recovery for the full-scale MF system of 90% was established. The process recovery for the Pall MF system is largely dependant on the interval setting between the air scour and reverse flush processes. The settings of 22- minute interval established as part of this testing could be applied to other wastewater reclamation installations.
 2. The cleaning procedure for the Pall MF system can be varied by the amount, re-circulation time and soak time of the chemical. It was important to establish an effective cleaning protocol to meet the required three week cleaning interval. The caustic portion of the cleaning was found to be more important than the acid portion, because majority of the fouling was found to be organic and not inorganic (mineral scale) fouling. This resulted in a nearly ten hour caustic solution re-circulation requirement as opposed to two hours of the acid re-circulation.
 - Recommendations:
 1. Continued testing is needed at the established process settings to verify long term validity.
 2. Microfiltration membrane integrity needs to be observed over a long-term period and testing using established cleaning procedure from this research be continued. Also, the procedure established here could be easily adjusted for other installations where water quality may differ.
 3. The power requirements established during this testing should be further compared with those established elsewhere for MF processes as well as with other conventional treatment technologies such as chemical clarification or multi-media filtration.

- Benefits to California: The benefit to California is the establishment of microfiltration technology as a viable alternative for large-scale wastewater reclamation. The use of MF technology will allow for greater reclamation to occur and reduce California's dependence on imported water sources. In most cases the land required for MF is several times smaller than that of current reclamation treatment processes. This testing has established a good estimate of the power requirements of MF technology for wastewater reclamation.
- Outcomes:
 1. UV Disinfection.
 - Biodosimetry challenges were conducted with MS-2 coliphage. Challenge results coupled with weekly monitoring of inactivation of heterotrophic bacteria showed that the UV reactor provided adequate disinfection of biofilter effluent. With 2 to 4 lamps on, bacteria were consistently reduced by more than 3 log10.
 - Study evaluated correlation between sensor and calibrated radiometer readings. Results indicate a linear relationship between the two. However, this relationship needs to be further characterized over a wider range of water quality (e.g., turbidity from 0.1 to 10.0 NTU) to understand sensor reliability for both filtered and unfiltered water applications.
 - Although this study showed successes in microbial challenges of the UV reactor, results will need to be verified at larger scales. Alternatives to biodosimetry need to be explored so that large California utilities may have other UV reactor dose-characterization options.
 2. Large-Scale Reverse Osmosis Desalination.
 - A 16-in. diameter RO element was operated in parallel with a conventional 8-in. diameter element for over 2,500 hours. The specific flux of the 16-in. element (0.23 gfd/psi) was 20 percent lower than the average specific flux of the 8-in. element (0.28 gfd/psi). Both elements removed greater than 98 percent of the influent TDS. Differences in the performance were attributed to design issues associated with the 16-in. element.
 - The large-diameter 16-in. elements are estimated to reduce RO plant capital costs by nearly 24 percent and overall costs (capital costs and O&M costs) by approximately 10 percent. Brine disposal costs were not included in the analysis. The use of large-diameter elements also reduced the overall plant footprint which resulted in a 24 percent savings for the building costs, as well as savings on system-wide controls and electrical equipment.
- Conclusions:
 1. This study developed a cursory correlation between sensor readings and calibrated radiometer readings that showed a linear relationship over the range studied.
 2. Although this study showed successes in microbial challenges of the UV reactor, larger-scale reactors will require validation. Alternatives to biodosimetry need to be explored so that large California utilities may have other UV reactor dose-characterization options.
 3. Large-diameter RO elements look very promising in reducing RO desalination costs for large-scale applications. Evaluation of one of the first 16-in. diameter prototype elements revealed that inefficiencies in the design currently exist. Membrane manufacturers are expected to improve the efficiency of the 16-in. element as research progresses.
- Recommendations: Additional research is needed to study:

1. The effects of water quality and water treatment chemicals on UV disinfection and alternatives to microbial biosimetry in characterizing UV reactor dose. Characterization of sensor readings to a known standard (i.e., radiometry) should also be continued.
 2. A second-generation 16-in. diameter element is needed to eliminate the inefficiencies observed in the first prototype element. Improvements in membrane design and optimization of the pretreatment process will help improve membrane productivity and reduce fouling, which minimizes both capital and O&M costs. An important issue in the future is loading and unloading of membranes. A dry 16-in.-diameter element weighs approximately 200 lbs and when wetted, an individual element can weigh over 300 lbs.
 - Benefits to California: UV treatment of drinking water could be a great benefit to California by allowing a relatively low-cost technology to provide enhanced disinfection and protection of public health. The development of large, 16-in. diameter elements will benefit the entire state of California by lowering the cost of desalination and reducing the energy requirements to treat brackish water. The successful development of these large-diameter elements will help to significantly lower cost of new, large-scale desalination facilities (greater than 100 mgd) by taking better advantage of economies of scale.
9. Technology Transfer.
- As research breakthroughs and other important results were achieved, EPRI and AWWARF provided an aggressive technology transfer effort including publishing technical information bulletins, organizing general information seminars, and conducting research needs assessment workshops to disseminate research findings to the municipal water community and related industries.

The information bulletins presented technical concepts in a reader-friendly format, incorporating graphics and easy-to-understand tables and charts. Because it is extremely important to emphasize communication between agencies and the general public, general information workshops were a major part of the technology transfer approach. The goals of the workshops were to present progress-to-date, exchange information, and obtain timely input. Three one-day workshops were held. The first workshop gathered input from industry experts, technology users, government agencies, and general participants to determine future workshop schedules and agendas. Workshop announcements, and a notification strategy, such as newspapers and trade journals, were proposed at the first workshop. Since research results often have a significant impact on the direction of future projects, the remaining two technical workshops were held to share technical information and provide feedback on research endeavors.

Project Status:

The Contractor presented the results at the CEC on January 17, 2002 on the project and the Final Report to Commissioners and staff. The complete final report will be posted on the PIER site in the Environmental Energy Research Program area.

HydrogenPinch™ Studies at the British Petroleum Los Angeles Refinery

Contract #: 100-98-001 **Project #:** 56

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Global Energy Partners, LLC : Linnhoff March Limited

Project Amount: \$95,038

Match Amount: \$95,038

Contractor Project Manager: Ed Fouche (919) 515-7550

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to conduct a hydrogen management study based on HydrogenPinch™ technology at British Petroleum's (BP's) Los Angeles refinery in Carson, California. The study will identify process and equipment changes to improve hydrogen recovery in the most cost-effective way and minimize the hydrogen vented to refinery fuel gas. The results of this study will benefit California refineries by showing how improved hydrogen recovery can achieve capacity debottlenecking, improved energy efficiency, improved product mix, and reduced environmental impacts.

The effective management and efficient integration of hydrogen and off-gases are becoming increasingly important tasks for many of the world's oil refiners and petrochemicals producers. Legislation to reduce global emissions of greenhouse gases is enforcing the production of low-sulphur fuels with the result that hydrogen is in increasing demand in refineries.

This project supports the PIER Program objectives of:

- Improving and enhancing the energy cost/value of California's electricity by developing and demonstrating an energy efficient industrial program, pinch technology.
- Improving the environmental and public health costs/risks of California's electricity by ensuring the cost-effective production and supply of low-sulphur fuels to meet strict environmental standards.

Proposed Outcomes:

This project will conduct a hydrogen management study based on HydrogenPinch™ analysis at the host site. Based on this analysis, researchers will calculate the maximum hydrogen recovery potential, the minimum supplemental hydrogen required from other sources, and the amount of propane required to maintain the heating value of the fuel gas. With these results, investigators will develop a list of recommended capital projects and/or process changes to meet the economic and operating criteria established by the plant.

Actual Outcomes:

The project team conducted a site visit of the BP facility to define data that needs to be collected and to determine operating and economic constraints that need to be taken into account. Researchers used HydrogenPinch™ analysis to determine the optimum extent of hydrogen recovery and minimal supplementary hydrogen required for the plant. Significant improvements were identified in three key areas: PRISM operation, plant capacity, and feed purity. The maximum potential cost savings achievable by combining these projects was shown to be \$4.5 million per year. In addition, further unquantified benefits could be realized in at least two hydroprocessing units due to an increase in purity of hydrogen supplies to those units. The global impact on the environment of California was shown to be positive by a 24,800 TPA reduction in CO₂ emissions. Results of the study were presented at a one-day seminar held on May 4, 2001 in

Long Beach, California. Seminar participants were from California refineries, California utilities serving refineries, and consultants to the refinery industry.

Project Status:

The project has been completed.

Industrial Demonstrations

Contract #: 500-00-022 **Project #:** 4 & 5

Contractor: Gas Technology Institute

Project Amount: \$150,000

Match Amount: \$193,600

Contractor Project Manager: Steve Sikirica (847) 768-0859

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The Forced Internal Circulation (FIR) burner will be demonstrated in a mesh belt furnace at the ITW CIW Stamping Plant's Santa Fe, California facility. This furnace contains 3 indirect heated zones containing 13 radiant U-tubes. Thirteen U-tube units (including burners and recuperators) will be removed and replaced with new U-tubes each fitted with GTI's FIR burner and a standard commercially available recuperator. Raising customer awareness of gas cooling opportunities.

Proposed Outcomes:

The following outcomes and deliverables are anticipated:

1. Development of FIR Burner for 6" Radiant U-Tube.
2. Field Demonstration.
 - Baseline Testing.
 - Installation of Burner System and Field Testing.
3. Evaluate and Prepare Technical Report.

Project Status:

- The first demonstration site of FIR was selected. It is a highly leveraged project that is funded by Mutual Fund Members (California Energy Commission, Dominion, and Energy West Inc.), GTI, Southern California Gas Company, California Air Resource Board's ICAT program, Eclipse Combustion (manufacturer), and ITW CPW Stampings (Santa Fe, CA) (host site).
- Task 1 for this project has been completed. GTI's FIR burner has been laboratory-tested and successfully proven to operate at or above desired levels when scaled up to accommodate a 6" radiant U-tube. Manufacturing drawings have been generated and approved with respect to the actual FIR burner to be installed at the demonstration site. Purchase Orders have been placed and manufacture has radiant tube manufacture has been completed and equipment delivered to the test site on September 20, 2002. The FIR burner equipment arrived at the test site on November 12, 2002. All equipment was inspected and accounted for and is safely being stored at the test site awaiting installation. This task has been completed.
- Task 2 (2.1): A full inspection of the test site and demonstration furnace at ITW CIP Stampings has taken place in order to set up the baseline testing. Baseline testing was conducted during the week of November 11, 2002. GTI analysis equipment was installed and three consecutive days of data collection followed. Analysis of these data has been completed and will serve as a comparison baseline reference in a case study of this demonstration project. This task has been completed.
- Task 2.2: Retrofit of the demonstration furnace with the FIR burner equipment was originally planned to occur during the test site's scheduled maintenance outage beginning December 20, 2002. However, ITW CIP Stampings experienced difficulties in securing the proper permits required to install the new FIR burner equipment. ITW is currently working with Yorke Engineering (consultants) to resolve any permitting issues and proceed with the installation.

Due to the required lead time for securing these permits, installation of the FIR burner equipment was not possible during the planned December, 2002 outage. This outage still took place, as scheduled, to perform the miscellaneous furnace maintenance. After getting the approval of required permits, installation of the FIR burner equipment took place at ITW stampings Inc. in 2003. All the thirteen burners, recuperators, and radiant tube assemblies were installed and ITW stampings were happy with the results. (ITW Stampings cooperated fully throughout this project).

Power Quality for Customer Systems - Program 2

Contract #: 500-00-023 **Project #:** 30

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: EPRI PEAC Corporation

Project Amount: \$150,083

Match Amount: \$591,559

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

- 2.004: Power Quality and Electromagnetic Compatibility Impacts on Robotics and Information Systems
- 2.005: Methodology for Determining Cost Recovery for "High Nine" Customers with On-Site Generation
- 2.007: Embedded Solution for Telecommunications and Internet Equipment
- 2.010: Advanced Flywheel and Ultracapacitor as Embedded Solutions for Advanced Machine Tools and Robotics
- 2.011: Cost Analysis and Reduction of Power Quality Mitigation Hardware
- 2.013: Power Quality and Powering E-Business Technology Watch

Project Description:

The purpose of this program is to provide the Commission with information about power quality concerns and mitigation techniques at commercial and industrial facilities, including those that rely on sensitive robotics and automation systems. The program addresses the unique needs of the digital economy, and evaluates innovative powering options for the Internet and telecommunications industries. It also offers expert insight into power conditioning issues, along with guidance on the proper selection, application, and installation of power quality mitigation hardware.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by providing knowledge to California ratepayers about how to mitigate power quality problems that cause equipment failures and process disruptions.

Proposed Outcomes:

1. Gather knowledge and develop a test database of susceptibility issues for robotics and automation systems. Explore device-to-device and device-to-environment power quality and electromagnetic compatibility issues.
2. Assess the benefit to the customer of providing utility service connections to customer sites that use on-site generation to fully offset their load. On-site generation is critical to meeting the "high nines" (up to 99.9999999%) of reliability required by some customers, such as Internet data centers. On-site generation is also an integral part of many internal electric customer distribution systems. For service providers, this raises serious economic issues: How can a utility justify the cost of new customer connections if zero-net sales of energy will occur at that site? How can a utility recover transmission and distribution infrastructure investments when existing customers add distributed generation (DG)? There are also serious questions about how much capacity should be built into the transmission and distribution system to handle contingencies for periods when customer DG is not available. To address these issues, this project will provide an analytical review demonstrating the technical benefit of having the utility connection

- present. This will be extremely useful to the utility when trying to assess service connection fees that are fair to both the customer and utility company.
3. Design embedded solutions for telecommunications and Internet equipment. Embedded solutions for the digital economy can help to bridge the gap between the quality and reliability of power required and the ability of digital loads to survive the electrical environment. This groundbreaking, multi-year project will evaluate the current design criteria for digital loads and the performance of the baseline design with respect to power quality immunity, and fault tolerance.
 4. Evaluate advanced flywheels and ultracapacitors as embedded solutions to improve the power quality performance of advanced machine tools and robotics. This project involves testing, technology demonstrations, and the integration of unique ride-through technologies into original equipment manufacturer equipment. In addition, a task force has been formed to facilitate development of industry standards for ride-through of such equipment.
 5. Build on previous EPRI work that developed a methodology for system cost analysis and a probabilistic framework for conducting cost analysis for power quality mitigation hardware. The focus in 2002 is to apply the methodology to actual customer power conditioning demonstration projects conducted by EPRI. Life cycle costs will be developed for several power quality mitigation devices. The new methodology will be verified using an actual customer power conditioning demonstration project.
 6. Provide late-breaking news on emerging power quality technologies and trends in powering e-business.

Actual Outcomes:

1. Power Quality and Electromagnetic Compatibility Impacts on Robotics and Information Systems.
 - In 2002 EPRI performed voltage-sag tests to measure the baseline effects of voltage sags on industrial robots. General Motors provided access to automotive robots for testing. A technical brief, *Power Quality Impacts on Robotic Automation Systems* (1001667), describes the test results.
2. Methodology for Determining Cost Recovery for "High Nine" Customers with On-Site Generation.
 - The project team drafted a technical report that assesses the technical benefit of providing a service connection to customer sites that use distributed generation to limit their energy utilization to essentially zero. The report is scheduled for publication in March 2003.
3. Embedded Solution for Telecommunications and Internet Equipment.
 - A technical report (1001670) was drafted that evaluates the current design criteria for digital load power supplies and performance of the baseline design with respect to power quality immunity and fault tolerance. An embedded solution was designed to provide longer ride-through in "sleep" mode. The report will be available in late March 2003.
4. Advanced Flywheel and Ultracapacitor as Embedded Solutions for Advanced Machine Tools and Robotics.
 - The project team prepared a technical report—*Advanced Machine Tool Embedded Solution* (1001673)—assessing the requirements of the robotics and machine tools industries to improve process uptime and identifying advanced technologies as embedded solutions for advanced machine tools and robotics. The report will be available in late March 2003.

5. Cost Analysis and Reduction of Power Quality Mitigation Hardware.
 - A technical report—*Life Cycle Cost Analysis of PQ Mitigation Devices* (1001674)—was developed that presents a case study demonstrating how system cost analysis using a probabilistic framework is conducted with real-life data from a power quality mitigation hardware demonstration project. The report will be available in late March 2003.
6. Power Quality and Powering E-Business Technology Watch.
 - Up-to-date information on power quality technologies and market trends is provided via web-based updates delivered electronically.

Project Status:

The project has been completed.

Production, Manufacturing, and Electronics Industries - Program 12

Contract #: 500-00-023 **Project #:** 36-37

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Global Energy Partners, LLC

Project amount: \$9,000

Match amount: \$6,285

Contractor Project Manager: Keith Carns (314) 935-8598

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

12.004: Cooling Water Cost Comparison Model

12.006: Electrotechnologies for Waste Reclamation

Project Description:

This program provides knowledge and tools to help production, manufacturing and electronics industries use electrotechnologies to solve environmental issues such as water treatment and waste reclamation in an informed, cost-effective manner.

This project supports the PIER Program objectives of:

- Supporting the development of new electricity applications to solve environmental problems by providing information and evaluation tools that help businesses apply electrotechnologies for water treatment and waste reclamation.
- Providing environmentally sound electricity by expanding the use of electrotechnologies that replace or supplement processes that may harm the environment.

Proposed Outcomes:

1. Develop a cooling water cost comparison model that allows users to evaluate and compare the costs of ozone cooling water technologies. The model will be available as an Excel spreadsheet that allows insertion of specific data to be analyzed.
2. Develop information on electrotechnologies for waste reclamation to support and promote the use of efficient, environmentally sound reclamation and recycling processes.

Actual Outcomes:

1. Cooling Water Cost Comparison Model.
 - A compact disk containing an Excel spreadsheet cost comparison model and examples was produced and delivered in 2002.
2. Electrotechnologies for Waste Reclamation.
 - A technical report—*Electrotechnologies for Waste Reclamation* (1005869)—was developed and made available as a downloadable PDF file or delivered on a compact disk.

Project Status:

The project has been completed.

Recycling Chiller-Bath Rinse Water in Poultry Processing

Contract #: 500-98-030

Contractor: WaterTech Partners

Contract Amount: \$520,912

Match Amount: \$144,000

Contractor Project Manager: Ronald Enzweiler (925) 283-4918

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Completed

Project Description:

The purpose of this project is to reduce the energy required in poultry processing by demonstrating the feasibility of using ozone-based water treatment technology to recycle chiller bath rinse water in poultry processing operations.

Presently, poultry processors use chlorine chemicals to disinfect the chiller-bath step and must discard the 0.5 gallons of chilled, chlorinated rinse water used per bird to meet USDA sanitary regulations.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity to electric ratepayers by reducing energy use or improving energy efficiency in the industrial sector.
- Improving the environmental and public health costs/risks of California's electricity by avoiding the use of chlorine disinfectants.

Proposed Outcomes:

Using the Mobile Treatment Demonstration Unit (MTDU) provided by EPRI, a feasibility will be conducted to:

1. Demonstrate that ozone is an effective anti-microbial sanitizer in poultry processing which can be safely used in direct contact with the birds.
2. Demonstrate that ozone does not create any harmful by-products or side effects when used as an anti-microbial sanitizer in poultry processing.

Actual Outcomes:

Upon obtaining U.S. Department of Agriculture (USDA) approval for a pilot-test program, WaterTech partners:

1. Designed, installed and operated a closed-loop, ozone-based pilot recycling system at a Petaluma, California poultry processing chiller line for six months.
2. Demonstrated that ozone is an effective anti-microbial sanitizer in poultry processing which can be safely used in direct contact with the birds.
3. Demonstrated that ozone does not create any harmful by-products or side effects when used as an anti-microbial sanitizer in poultry processing.

The successful pilot-scale testing resulted in USDA approval for replacing chlorine with ozone in the chiller-bath process of the poultry-processing industry. The project achieved energy savings by returning the filtered and disinfected chiller-bath overflow water to the heat exchanger used to chill water for the chiller bath. Since the average temperature of the feed water will be reduced to about 50 degrees F from 75 degrees F, the refrigeration load will be dramatically reduced which, in turn, will lower overall system energy requirements.

Project Status:

The project has been completed. The final report is available. For more information, please contact Ricardo Amon at (916) 654-4019.

IAW Projects Completed in 2001

Assessing the Impact of Power Quality for California Industries

Contract #: 100-98-001 **Project #:** 37

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$32,500

Match Amount: \$32,500

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project description:

This project's goal is to understand the impact of power quality on California industries and assess the technical and economic criteria for developing effective technologies for power quality mitigation. This information will help improve the productivity of California industries by reducing the impact of power quality through targeted R&D based on the needs of particular industrial segments.

The proliferation of sensitive electronic loads has raised concern in many California businesses about the quality of power and its potential negative impact on productivity, downtime costs, lost product, energy utilization, global competitiveness, and the environment. The Commission has a programmatic approach to invest in the R&D of new power quality mitigation technologies. One critical feedback that is required in order to channel the future R&D needs for power quality mitigation technologies is to clearly understand the unique power quality problems affecting California industries and the loss of productivity due to power quality problems. There is a need for obtaining credible feedback from California industries regarding power quality problems and their impact.

This project supports the PIER Program objectives of:

- Improving the Reliability/Quality of California's Electricity by developing knowledge and tools to solve power quality problems that cause equipment failures and process disruptions.
- Improving the Energy Cost/Value of California's Electricity by reducing process inefficiency associated with power quality disturbances.

Proposed Outcomes:

1. Identify the characteristics of energy storage requirements and power quality mitigation characteristics for emerging technologies that can be applied by customers for power quality mitigation.
2. Assess the cost impact of power quality on California industries and define a target range for mitigation hardware cost in \$/kW or \$/kVA.

Actual Outcomes:

The project team developed and distributed a survey to identify the perceptions of California industries regarding the quality of power they receive, the most common issues, and the most appropriate R&D to undertake to solve the problems faced by industry. The survey results were analyzed, and a final report was submitted to the Commission. Conclusions were the need for the following:

1. Training and education of California's commercial and industrial energy consumers.
2. Power quality monitoring programs by utilities and their customers.
3. Development of mitigating technologies.
4. Field investigative services and technology demonstration.

5. An expanded power quality knowledge base.
6. Creation and expansion of power quality standards for end-use equipment.

This information will help improve the productivity of California industries by reducing the impact of power quality on sensitive loads, and by avoiding downtime costs and lost product.

Project Status:

The project has been completed.

Customer Power Conditioning Solutions - Target 4

Contract #: 500-00-023 **Project #:** 1

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: EPRI PEAC Corporation : Enable Fuel Cell Corporation

Project Amount: \$149,947

Match Amount: \$1,486,946

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to address the power quality (PQ) issues facing commercial and industrial energy users who are using devices that are more sensitive to PQ variations. Sensitive loads often are in extensive networks and automated processes, and many loads use power electronics for power conversion. These new, technology-driven changes have created a growing concern in many California businesses about the quality of power and its potential negative impact on productivity, downtime costs, lost product, energy utilization, global competitiveness, and the environment. These concerns focus on power quality mitigation equipment—that is, power conditioning and energy storage equipment that can protect loads from PQ variations.

EPRI research efforts have identified voltage sags and momentary interruptions as the two most important categories of power quality variations affecting end users. Traditional power quality mitigation technologies such as uninterruptible power supply systems can address these problems but at a substantial cost and sometimes with marginal performance. EPRI's Customer Power Conditioning Solutions Target provides information about the best and most cost-effective power conditioning and energy storage equipment available, and the technical expertise to help California ratepayers use the equipment properly. This target provides information on power conditioning issues, along with guidance on the proper selection, application, and installation of power conditioning and energy storage equipment. It also identifies and demonstrates new and innovative technologies with high commercialization potential such as advanced flywheels and ultracapacitors.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by providing knowledge to California ratepayers about how to mitigate power quality problems that cause equipment failures.

Proposed Outcomes:

1. Produce system compatibility test protocols for determining the feasibility of applying local generation and its effects on power quality in customer environments.
2. Investigate the susceptibility of advanced computer numerically controlled (CNC) machine tools to voltage sags, assess the possibilities of cost-effective embedded power quality solutions, and illustrate the concept of embedded solutions with case studies.
3. Demonstrate how to conduct a life-cycle cost analysis for a power quality mitigation project at a commercial customer site and incorporate statistical information in the decision-making process.
4. Develop case studies to evaluate the power quality implications of hybrid systems consisting of power quality mitigation hardware and energy delivery and energy storage systems.

5. Provide laboratory data and performance analysis of a proton exchange membrane (PEM) fuel cell designed for power quality applications.
6. Conduct an EPRI Tailored Collaboration (TC) project entitled "Assessing the Impact of Power Quality for California Industries."
7. Conduct an EPRI TC project entitled "Guidebook on Power Quality Guidelines for Energy Saving Products."
8. Conduct an EPRI TC project entitled "Emerging PQ Mitigation Product Demonstration at Customer Sites."
9. Conduct an EPRI TC project entitled "Optimization of Electric Energy Consumption in Marginal California Oilfields."

Actual Outcomes:

1. A report—Distributed Generation Source Stiffness and Its Impact on Voltage Distortion, 1005922—was published on an evaluation of voltage distortion resulting from application of nonlinear load for three different types of rotary generators and one inverter-based generator.
2. A report—PQ Mitigation Technology, Market, and Cost: Advanced Machine Tool 2001 Efforts, 1005923—was published on the effects of voltage sags on advanced machine tools and the use of power conditioning equipment to mitigate these disturbances. A report—Embedded Solutions for Advanced Machine Tools: Field Demonstration and Test Results, 1005924—was published on field case studies related to voltage sag testing of computerized numerical control (CNC) machining.
3. A report—Development of Probabilistic Analysis Tools for Optimal Selection of Power Quality Mitigation, 1005925—was published to provide a comprehensive methodology for performing an economic analysis of the life-cycle cost for power quality mitigation hardware solutions.
4. A report—Case Studies, 1005926—was published on power quality implications of an existing hybrid installation.
5. A report—Evaluation of a 3-kW Proton Exchange Membrane (PEM) Fuel Cell 1005927—was published to document results of a demonstration of a PEM fuel cell for power quality applications such as UPS systems and replacement for lead-acid batteries.
6. Tailored Collaboration: Assessing the Impact of Power Quality for California Industries. Researchers developed and distributed a survey to identify the perceptions of California industries regarding the quality of power they receive, the most common issues, and the most appropriate R&D to undertake to solve the problems faced by industry. The survey results were analyzed, and a draft report was submitted to the CEC for review and comment. Once comments are received, EPRI will publish the final report. This information will improve the productivity of California industries by reducing the impact of power quality on sensitive loads, and by avoiding downtime costs and lost product.
7. Tailored Collaboration: Guidebook on Power Quality Guidelines for Energy-Saving Products. The project team identified the characteristics of power quality issues related to energy-saving products, developed guidelines for minimizing power quality impacts, and created tools for evaluating energy-saving claims from "black-box" type energy-saving devices. This information will remove one of the barriers to application of energy-saving devices by California industries, and enable users to apply these products without power quality impacts.
8. Tailored Collaboration: Emerging PQ Mitigation Product Demonstration of Customer Sites. Investigators arranged for the field demonstration of power quality mitigation technologies at California industry locations. Technology evaluations and economic assessments were conducted. Site selection and survey and auditing of the site are under way. Once these are complete, EPRI will publish the results of Phase I and produce a

- draft proposal for Phase II. The field demonstration will be conducted in Phase II. Results will offer California industries real-life application experience with new technologies.
9. Tailored Collaboration: Optimization of Electric Energy Consumption in Marginal California Oilfields. Oilfield surveys completed by May 2001 collected data from 19 fields. The field data represented 939 producing wells, of which 91% were rod-pumped wells. Existing and new technologies were reviewed to improve oilfield electrical efficiency. Extrapolation of these results to all wells in California could result in a total benefit that could exceed 139 GWh/M in reduced power consumption and a demand reduction exceeding 221 MW. If these suggestions were implemented, a reliable system-wide demand reduction may be realized by energy suppliers through reduction of the need for additional generation and power infrastructure. Results were published in Optimization of Electric Energy Consumption in Marginal California Oilfields, 1006487.

Project Status:

The project has been completed.

Guidebook on Power Quality Guidelines for Energy Saving Products

Contract #: 100-98-001 **Project #:** 38

Contractor: Electric Power Research Institute (EPRI)

Project Amount: \$37,500

Match Amount: \$37,500

Contractor Project Manager: Ashok Sundaram (650) 855-2304

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project description:

This project's goal is to develop information to help California industries to understand the power quality issues associated with energy-saving products so they can use these devices properly and minimize equipment disruptions due to power quality side effects.

Electric motors account for more than half of total energy usage in the industrial sector. Several types of technology are used to reduce the energy consumption of motors, including adjustable speed drives, motor voltage controllers, power factor correction capacitors, energy efficient motors, and, in some cases “black-box” type devices that claim considerable energy savings potential. Many California industries lack the information to understand the energy savings potential claimed by a number of “black box” type devices. In addition, the use of some energy-savings products may cause equipment to operate incorrectly due to incompatibility of the device and the equipment. This has, in some cases, caused a negative perception among users regarding application of energy savings products.

By developing practical guidelines for these energy saving products, this project will help users to apply these devices while avoiding power quality problems. This will remove one of the barriers in the application of energy savings products by California industries.

This project supports the PIER Program objectives of:

- Improving the Reliability/Quality of California's Electricity by developing knowledge and tools to avoid solve power quality problems that cause equipment failures and process disruptions.
- Improving the Energy Cost/Value of California's Electricity by reducing process inefficiency associated with power quality disturbances.

Proposed Outcomes:

1. Identify the power quality issues and their characteristics related to energy saving products, focusing mainly on energy savings measures for motors and lighting.
2. Identify the characteristics of “black-box” type energy savings products and, based on literature searches and prior testing conducted by EPRI, evaluate the potential for energy savings.
3. Develop guidelines for the application of energy saving products to minimize incorrect equipment operation as a result of power quality problems.

Actual Outcomes:

The project team identified the characteristics of power quality issues related to energy-saving products, developed guidelines for minimizing power quality impacts, and created tools for evaluating energy-saving claims from "black box" energy-saving devices. EPRI delivered a report, *Power Quality Guidelines for Energy Saving Products*, to the Commission. This

information will help remove one of the barriers to application of energy-saving devices by California industries, and enable users to apply these products without power quality impacts.

Project Status:

The project has been completed.

Summer Electric Load Reduction in California's Cast Metal Industry

Contract #: 500-00-012

Contractor: California Cast Metals Association

Contract Amount: \$126,606

Contractor Project Manager: James Simonelli (916) 933-3062

Commission Contract Manager: Rajesh Kapoor (916) 654-4611

Status: Completed

Project Description:

The purpose of this project is to develop energy efficient metal melting methods and operating procedures for the metal casting industry in California. Metal melting accounts for approximately 55 percent of the total energy used at a foundry. California is ninth in the US in tonnage of castings produced, and the industry employs more than 20,000 people. Survey forms were sent to over 200 foundries, die casters and smelters operating in California. All of the responders indicated that they were not capturing waste heat from melting furnaces and that 25 percent their operating costs were for energy. Only 28 percent had some type of energy monitoring on melting operations. The methods and procedures developed in this project will help reduce electrical energy consumption and minimize the impact of possible electrical interruptions.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by reducing the electrical energy use during the metal melting processes.
- Improving the reliability/quality/sufficiency of California's electrical system by developing the energy efficient methods/procedures to melt the metal for the metal casting industry.

Proposed Outcomes:

1. Average expected savings of 20 percent for the energy used in each metal melting operation by using the techniques developed under this contract.
2. Every cast metal facility in California that can benefit from these energy conservation methods will get the report and CD-ROM explaining the procedures to save the energy, time, and the resources.
3. Reduce the electrical load and electrical consumption in metal melting facilities in California and avoid the electrical interruptions in the summer.

Actual Outcomes:

1. The information received in the Metal Melting Survey gave a profile of California metal melting operations that were segmented into two groups, Ferrous and Non-Ferrous. There is a large variation in the type of castings produced at the facilities responding to the survey. The three largest tonnage operations in California produce approximately 50 percent of the total tonnage. The remaining 200+ foundries represent smaller operations that have limited technical resources and most need the suggestions presented in this report.
2. A copy of the report was distributed to the California cast metal industry.
3. Facilities implementing the report's recommendations can be expected to achieve average savings of 20 percent for metal melting operations.

Project Status:

The project was completed within the budget and Commission received the final report in December 2001.

IAW Projects Completed in 2000

1999 & 2000 Agriculture

Contract #: 100-98-001 **Project #:** 29

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Edison Technology Solutions/Southern California Edison : Electrochemical Design Associates : G & L AgriTec : Hawaiian Electric Company, Inc. : North Carolina State University : ProWrite, Inc. : Purdue University : SoilZone, Inc. : Texas State Technical College : University of Georgia, Research Foundation, Inc. : Jonne Berning

Project Amount: \$169,000

Match Amount: \$693,377

Contractor Project Manager: Myron Jones (650) 855-2993

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Completed

Project Description:

The purpose of this project is to offer a complete package of advanced energy solutions and technical support to increase farm production and reduce costs. U.S. farms spend about \$12 billion each year for energy. Approximately \$3.8 billion of that goes toward electricity purchases. Efficient use of electricity has a critical impact on profitability. Today's farmers and agribusinesses rely heavily on advanced technologies and science to turn a profit. Where once farmers turned a watchful eye to the sky for signs of rain, satellites now give them detailed snapshots of weather conditions around the country. Farmhands have been replaced by energy-efficient motors and other electrotechnologies to the tune of 44 billion kWh of electricity consumption annually. This EPRI target also provides marketing communications tools to provide access to these energy solutions to agribusinesses.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing energy solutions for agribusinesses to increase farm production and reduce costs.
- Improving the environmental and public health costs/risks of California's electricity by demonstrating the use of ozone as a replacement for chemicals such as methyl bromide for purification, fumigation, and disinfection.

Proposed Outcomes:

1. Support the potential for use of ozone in place of chemicals or other methods in agriculture.
2. Provide experience and knowledge on innovative technologies and practices to increase production and reduce costs in agribusiness.
3. Support the use of energy-efficient technologies and practices in agriculture.
4. Conduct a Tailored Collaboration entitled "Predicting Agricultural Growth After Ozone Treatment" to test the technical efficacy of treating agricultural soils with on-site generated ozone gas to reduce pest pressures on plant growth.

Actual Outcomes:

1. Use of ozone.
 - A report was published entitled Ozone in the Food and Agriculture Industries.
 - A petition was made to the Federal Drug Administration to gain regulatory acceptance of ozone treatment of food products in agriculture and food processing. The petition is under review by the FDA and a ruling is expected in 2001.

- An ozone conference was held in September 1999 in Tulare, and abstracts were published.
- 2. Technologies and practices to increase production and reduce cost.
 - A report was published on freshwater recirculation aquaculture systems that hold the potential to make fishfarming more profitable.
 - A report was published on a North Carolina demonstration of an aquaculture facility utilizing water re-use technology.
 - Results of a study were published on poultry spiking mortality, highlighting the importance of purified drinking water in poultry production.
 - Results of study were published on stray voltage and animal sensitivity levels.
 - A report was published on the potential for drip irrigation of technical row crops.
 - Information was published on a greenhouse study of very intense lettuce production.
 - A report was published on closed-cycle shrimp farming.
- 3. Energy efficient technologies and practices.
 - A report was published on the McLeod harvest method, an innovative grain harvesting technology that offers a promising alternative to combine harvesting, especially for small farms.
 - Technical and energy consumption information were published on the application of variable-speed drives to increase the energy efficiency and controllability of agricultural fans.
 - Findings were published on the use of static phase adaptors to utilize 110-volt current on large three-phase irrigation motors.
- 4. Field trials were conducted for several crops, including carrots and tomatoes, and initial success was reported. Results were summarized in a report entitled Ozone Gas as a Soil Fumigant.

Project Status:

The Commission's participation in this target ended as of December 31, 2000.

1999 & 2000 Food Processing

Contract #: 100-98-001 **Project #:** 27

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Apogenics, Inc. : C&S AgriSystems : Cornell University : Edison Industrial Systems Center : Iowa State University : New York State Energy Research & Development Assoc (NYSERDA) : Plumrose USA, Inc. : ProWrite, Inc. : Sandridge Food Corporation : University of California, Davis : University of Minnesota : Washington State University : WaterTech Partners : Graham Dee : Imbroglia Cures Inc.

Project Amount: \$192,000

Match Amount: \$803,471

Contractor Project Manager: Myron Jones (650) 855-2993

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Completed

Project Description:

The purpose of this project is to provide California's food processing industry with new electrotechnologies that increase energy efficiency and reduce environmental impacts that can help keep this sector of the California economy productive and energy efficient. Concerns about the worldwide environment and demand for food are just a few of the many challenges this important sector of California industry must meet to stay competitive. A competitive food processing industry is more likely to stay in California and ensure that California's rapidly growing population has a safe and adequate food supply. EPRI offers the latest tools and information such as technical services, communication tools, and innovative initiatives that focus on food safety—a top priority among consumers and regulators today. Electrotechnologies like ozonation and pulsed power for sanitation are some of EPRI's state-of-the-art solutions to the industry's most pressing concerns.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing and implementing technologies that improve productivity and energy efficiency for food processing industries.
- Improving the environmental and public health costs/risks of California's electricity by reducing fresh water supply needs, plant wastewater discharge, and improved food sterilization.

Proposed Outcome:

1. Support research and provide information to improve the competitiveness of the California food processing industry through implementation of technologies that increase energy efficiency, reduce environmental impacts, and provide safer, more productive processes.

Actual Outcome:

1. Research and information to improve the competitiveness of the food processing industry.
 - Results were published of a study of membrane treatment to reduce water use and ozonation for sanitation at a poultry processing plant.
 - A resource guide was published for evaluation of food irradiation options.
 - Technical and market information were compiled on the use of ozone for improved sanitation and water treatment in food processing.

- Three reports were published on membrane treatment, pulsed power technologies, and other process water treatment options.
- Research results were reported of a study of the use of electron beam irradiation and high-pressure technologies to reduce the effects of microorganisms on poultry products.
- The food industry scooping study report was revised and updated as Food Industry 2000. The report provides an overview of the food industry.
- Findings were released from a study that tested the use of ozone as a replacement for chlorination in wheat steeping water used in wheat processing.
- A monthly newsletter was published on developments and trends in the food processing industry.
- EPRI's Membrane Trailer Demonstration Unit made on-site visits to a food processor to demonstrate and test advanced membrane technologies.

Project Status:

The Commission's participation in this target ended as of December 31, 2000.

Chemicals, Petroleum and Natural Gas - Target 23/2.6

Contract #: 100-98-001 **Project #:** 30

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Advanced Resources International, Inc. : Chemicals & Petroleum Management, Inc. : Edison Technology Solutions/Southern California Edison : El Paso Energy Corp. : Hawaiian Electric Company, Inc. : Kennedy/Jenks Consultants, Inc. : Lockheed Martin Energy Systems, Inc. : Massachusetts Institute of Technology : Niro Process Technology : Taratec Corporation : University Of Florida : University of Patras : Veritech, Inc. : ISOPro International : Optima Engineers & Co. : ProWrite, Inc. : Resource Dynamics Corporation

Project Amount: \$200,000

Match Amount: \$918,489

Contractor Project Manager: Ammi Amarnath (650) 855-2548

Commission Contract Manager: John Sugar (916) 654-4563

Status: Completed

Project Description:

The purpose of this project is to provide chemical and petroleum companies methods to cut energy costs while improving productivity and yield. It will also provide information for companies reviewing options for generating on-site electricity and seeking the latest and most cost-effective advances in pollution control. To stay productive and profitable, decision-makers in this market sector must address a host of economic and environmental concerns. EPRI provides information and technical expertise on advanced systems for wastewater reduction, soil remediation, and fluid transport to increase the value of electricity as this segment of California industry enhances environmental compliance and lowers operating costs.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing information on reducing wastewater discharge and improving soil remediation techniques for the chemical, natural gas, and petroleum industry.
- Improving the environmental and public health costs/risks of California's electricity by providing information to reduce the impacts on the environment by the chemical, natural gas, and petroleum industry.

Proposed Outcomes:

1. Encourage the use of ozonation in process industries through a demonstration project at an industrial site in California.
2. Improve the understanding of power quality needs of large industrial complexes.
3. Provide information to encourage reduction of wastewater for process industries.
4. Provide marketing and communication tools to increase use of energy efficient technology in chemicals and petroleum process.
5. Provide information to increase use of energy efficient technologies in chemical, natural gas, and petroleum processes.
6. Conduct a Tailored Collaboration entitled "Development and Demonstration of Liquid Membrane Technology for MTBE Mitigation in Aqueous Streams" for the reduction and removal of MTBE contamination in the California water supply.
7. Conduct a Tailored Collaboration entitled "Hydrogen Pinch Studies at Arco's Wilmington (CA) Refinery" in order to identify process and equipment changes to improve hydrogen recovery in the most cost-effective way.

Actual Outcomes:

1. This proposed outcome was replaced by the Tailored Collaboration entitled “Characterizing Power Quality and Specifying Solutions at a Food Processing Plant” conducted under EPRI Target 38, Power Quality for Improved Industrial Operations.
2. This proposed outcome was replaced by the Tailored Collaboration entitled “Hydrogen Pinch Studies at Arco’s Wilmington (CA) Refinery” and described in item #7 below.
3. Wastewater reduction.
 - A comprehensive report was published that identifies and characterizes current and potential water management technologies.
 - A Water Management Workshop was held in conjunction with EPRI’s AIChE’s Center for Waste Reduction Technologies.
4. The *Supply Side Management Kit* was produced, including brochures, guidebooks, case studies, and other promotional and education materials regarding electricity and gas sales, distribution system reliability, cogeneration, tariff analysis, and asset management.
5. Information to increase use of energy efficient technologies.
 - A scoping study report was published on enhanced oil recovery technologies.
 - A report was published on Pinch screen analysis to maximize process energy efficiency.
 - A report was published about a promising membrane process that delivers environmental and economic benefits by recovering valuable feedstocks in polyolefin plants.
 - A TechApplication document was published outlining the economics and emission reduction advantages of electric compression for natural gas storage and pipelines.
 - Market and technical information were compiled about a major business trend in the chemicals industry—the move into the high-margin segments of life sciences and specialty chemicals.
 - A report was published on trends, issues, and opportunities in healthcare.
 - A monthly newsletter was published on industrial trends and developments.
 - The Third Gas/Electric Partnership Symposium was held, bringing together representatives from electric power, gas pipeline, and service industries to pursue partnerships.
 - An overview course was presented on the petrochemical industry.
6. EPRI completed a final report—*Development of Supported Polymeric Liquid Membrane Technology for Aqueous MTBE Mitigation* (1006577)—in November 2002. A technology transfer seminar was held in February 2002. See separate write-up in this annual report with the title “Development and Demonstration of Liquid Membrane Technology for MTBE Mitigation in Aqueous Streams”.
7. For a new methodology called Hydrogen Pinch, the project team collected and analyzed data at Arco’s refinery in Los Angeles, and made recommendations for applying the methodology in efforts that could yield a total annual savings for the refinery of about \$4.5 million. See separate write-up in this annual report with the title “HydrogenPinch™ Studies at the British Petroleum Los Angeles Refinery”.

Project Status:

The project has been completed.

Customer Power Conditioning Solutions

Contract #: 100-98-001 **Project #:** 3

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Power Electronics Applications Center : Adjustable Speed Drive
Demonstration Office Maxwell : Trinity Flywheel Power Corp : Diversified Commercial
Hydrogen Technology, Inc. : Pillar Flywheel Co. : Active Power : Electrotek Concepts, Inc. :
Ureco (England) : Oregon State University : Precise Power Corp : Teco-Westinghouse :
University of Texas, Austin : Power Cell Co.

Project amount: \$817,500

Match amount: \$3,797,237

Contractor Project Manager: Ben Banerjee (650) 855-7925

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project was to address the power quality (PQ) issues facing commercial and industrial energy users who are using devices that are more sensitive to PQ variations. Sensitive loads often are in extensive networks and automated processes, and many larger loads use power electronics for power conversion. These new, technology-driven changes have created a growing concern in many California businesses about the quality of power and its potential negative impact on productivity, downtime costs, and lost product. These concerns focus on power quality mitigation equipment, that is, power conditioning equipment that can protect loads from PQ variations.

EPRI research efforts have identified voltage sags and momentary interruptions as the two most important categories of California's power quality variations affecting end users. Traditional power quality mitigation technologies such as uninterruptible power supply (UPS) systems can effectively address these problems, but at a substantial cost. EPRI's Target 35 provides information about the best and most cost-effective power conditioning equipment available, and the technical expertise to help California ratepayers use the equipment properly. This target provides information on power conditioning issues, along with guidance on the proper selection, application, and installation of power conditioning equipment. It also identifies and demonstrates new and innovative technologies with high commercialization potential such as Advanced Flywheels, Advanced Voltage Regulator/UPS and Line Fault Protector, and Voltage Sag Ride-Through Devices.

State-of-the-art power electronics provide higher-performing solutions, integrating voltage regulation for entire customer loads, and UPS for a defined priority load. Built-in load management allows customers to prioritize loads to keep all loads supported through voltage sag and critical loads supported through an extended outage. The price point is very attractive when compared to existing UPS or voltage regulator systems. Using an advanced voltage regulator/UPS and line fault protector to power equipment through voltage sags and momentary interruptions could eliminate California industry and ratepayer power quality interruptions.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by providing knowledge to California ratepayers about how to mitigate power quality problems that cause equipment failures.

Proposed Outcomes:

1. Provide California ratepayers the opportunity to apply the advanced flywheel, a cost-effective energy storage technology, to ride through power quality events.
2. Provide California ratepayers the opportunity to apply the supercapacitor, a cost-effective energy storage technology, to ride through power quality events.
3. Provide California ratepayers the opportunity to apply the advanced voltage regulator/UPS and line fault protector, cost-effective energy storage technologies, to ride through power quality events.
4. Reduce the cost of power conditioning.
5. Conduct a Tailored Collaboration entitled "Determining the Power Quality Implications on Distribution Grid of Disbursed Electric Motors Prevalent in California's Oil Fields."

Actual Outcomes:

1. A comprehensive assessment was made of the feasibility of commercializing high-power/high-energy density flywheel batteries for uninterruptible power supply (UPS) systems for electricity customers and electricity suppliers.
2. Test results indicated that advanced power conditioning technologies such as supercapacitors could be integrated into the power supply of advanced machine tools to mitigate the effects of voltage sags, provide ride-through, and replace batteries used to maintain controller memory.
3. Several outcomes to provide ride-through power quality.
4. A new power-conditioning device—a hybrid adjustable voltage regulator/uninterruptible power supply (AVR/UPS) was developed and tested. This novel device is the first tool in the US and abroad to provide separate voltage regulation and UPS function to distinct loads from one power line conditioner.
5. An evaluation showed that advanced fuel cells have advantages over traditional UPS systems for short-term ride-through of voltage sags and momentary interruptions, and offer long-term back-up power not available from other systems.
6. A preliminary design was made of a medium-voltage dynamic sag corrector, and an assessment was made of the product's market potential and cost.
7. Several outcomes to reduce the cost of power conditioning.
8. A report compiled up-to-date information on current and projected prices for power quality mitigation equipment and the most significant market barriers to cost reductions.
9. A methodology was developed to accurately estimate life-cycle costs for mitigation equipment options.
10. Information was compiled on the power conditioning needs and mitigation hardware for the telecommunications industry.
11. An evaluation was made of the characteristics and system compatibility issues related to a new generation of power quality hardware for alternate energy systems, load leveling, and motor starting. An integration of supercapacitors and fuel cells has been completed and tested, and a high-speed flywheel and drive were installed and tested.
12. Power quality implications of electric motors in oil fields.
13. A press release was posted on the web to announce the project.
14. A report was published to provide a tutorial on components and artificial lifts typically associated with small oilfield operations.

15. Oilfield tours were conducted at six sites, including THUMS, Tideland, McPherson, Oxy USA, San Joaquin Management, and Holmes. A report was published summarizing findings from the tours.
16. A draft site survey questionnaire document was completed and posted on the web.
17. Additional tasks—including workshops and reports—are to be completed.

Project Status:

The Commission's participation in this target ended as of December 31, 2000. Participation in the Tailored Collaboration ended in 2001.

Electronics Industry

Contract #: 100-98-001 **Project #:** 11

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: J&M Associates : Alzeta Corporation : International Sematech : Sematech, Inc.

Project Amount: \$80,000

Match Amount: \$551,868

Contractor Project Manager: William Smith (650) 855-2415

Commission Contract Manager: Clint Lowell (916) 654-4554

Status: Completed

Project Description:

The purpose of this project is to address the major energy, productivity and environmental issues of the expanding California electronics industry. Industries in this rapidly growing market sector—including manufacturers of semiconductors, printed wiring boards, telecommunications equipment, computers, and peripherals (all major California industries)—face these issues as they strive to sustain or expand their position in the global marketplace. Yield, equipment utilization, energy efficiency, power quality, and water management are essential issues that all California electronics manufacturers must address. In addition, many firms in this internationally competitive industry strive to keep their product development efforts highly confidential.

EPRI's Electronics Industry Target follows a twofold strategy in working with these proprietary-minded industry sectors. The initial step in engaging any electronics industry sector involves the creation of an "industry gateway" through the formation of strategic alliances and project partnerships with industry organizations, through which project proposals may be credibly prioritized. The second step entails developing leveraged projects that create products of mutual interest to the industry sector(s) involved and the target funders. Such leverage may come in the form of supplemental funding from target funders or access to industry funded project results that only target funders can obtain. This strategy increases the likelihood that the project results will be used by the industry sector(s) that can benefit from those results, as the industry gateway approach permits a continuing connection to industry, even after a specific project has been completed.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by promoting energy efficient manufacturing tools and processes, including manufacturing facility operations. The target also promotes electrotechnology applications (e.g., for water management) that result in the minimum use of electricity per unit of product, while maximizing the value of electricity by reducing overall production costs.
- Improving the environmental and public health costs/risks of California's electricity by engaging in research to improve air, water, and solids emissions through pollution prevention, in-plant recycling, and end-of-pipe mechanisms in electronics plants.

Proposed Outcomes:

1. Provide information to accelerate the development and market penetration of energy- and water-efficient technologies to make productivity and environmental gains in California electronics manufacturing.
2. Compile and disseminate up-to-date information on electronics industry market conditions, primary issues, available technologies for addressing these issues, and industry research progress and needs.

Actual Outcomes:

1. Energy- and water-efficient technologies for electronics manufacturing.
 - A report was published describing an evaluation of a perfluorocompound (PFC) capture and recovery unit designed to extract PFCs from the combined exhaust of 20 or more tool process chambers.
 - A report was published on good tool exhaust optimization practices that will help California companies reduce clean-room energy use and makeup air costs associated with inefficient static pressure losses and exhaust from process tools.
 - Access was given to six 1998 reports. These reports included: Summary of Wafer Rinse Optimization Studies at Advanced Micro Devices (AMD), Motorola, and Texas Instruments (TI) Fabs, International 300 mm Initiative (I300I) Tool Utility Usage Study, Evaluation of an SG Water Systems GmbH Prototype Electrodeionization (EDI) Unit, Addendum to the Sandia Evaluation of an SG Water Electrodeionization (EDI) Unit Report, Evaluation of Commercially Available On-Line Total Oxidizable Carbon (TOC) Analyzers for Monitoring Recycled Water, and Wafer Rinse Optimization Studies at Digital-Intel, SEMATECH, and Texas Instruments Fabs: Summary Report.
2. A report entitled the Worldwide Fab Energy Survey Report was published.

Project Status:

The Commission's participation in this target ended as of December 31, 1999.

High Efficiency Steam Generation (#1218)

Contract #: 100-98-003 **Project #:** 4

Contractor: Gas Research Institute

Subcontractors: COEN Company, Inc. : GTI Performing Laboratory : Detroit Stoker

Project Amount: \$75,000

Contractor Project Manager: Ron Edelstein (847) 768-0889

Commission Contract Manager: Brian Laan (916) 653-7963

Status: Completed

Project Description:

The purpose of this project was to develop high-efficiency, ultra-low NO_x emission technologies for industrial packaged boilers. The major activity under the project is the complete field trials of low and ultra-low NO_x boiler burners.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by utilizing natural gas-fired low and ultra-low NO_x emission technologies.
- Improving the public health costs/risks of California's electricity by advancing the efficient use of low-emission natural gas.

Proposed Outcomes:

1. Ultra-Low NO_x Retrofit Boiler Burner: The ultimate goal of the project is to develop industrial boilers with efficiencies above 90 percent and NO_x emissions below 5 ppm. Complete a field installation in a Department of General Services (DGS) building in the Sacramento area.
2. FIR Low NO_x Burner: Develop an ultra-low NO_x burner without external flue gas re-circulation to achieve under 9 ppm NO_x. The long-term target is to reach below the 5-ppm NO_x level. Applications are targeted for boilers and various industrial process heaters.
3. Methane deNO_x – Biomass: Expand the gas reburn technology to stoker-fired boilers using various E-fuels, wastes, and biomass and demonstrate that Methane deNO_x can be a low cost approach to bring solid fuel boilers into environmental compliance while offering many operational benefits.

Actual Outcomes:

1. Ultra-Low NO_x Retrofit Boiler Burner: Sub-5 ppm NO_x achieved at Coen's California boiler test facility. The installation at the State of California's DGS central heating plant in Sacramento, with target of <9 ppm, was completed. All performance targets exceeded design parameters.
2. FIR Low NO_x Burner: Burner sizes at 2.5, 6, and 20 million Btu/hr have been developed. The 6 and 20 million Btu/hr burners have shown 10-15 ppm NO_x in a boiler in Monroe, Michigan. The demonstration of a 2.5 million Btu/hr burner performing at 9-15 ppm NO_x in a packaged boiler at Vandenburg Air Force Base in Southern California is completed. A 60 million Btu/hr burner test at Miller Brewery showed 10 ppm NO_x performance after modifications to burner-to-boiler seal were made.
3. Methane deNO_x – Biomass: The field test at the Boise Cascade plant was successfully completed in 2000 to show that Methane deNO_x can reduce 40-50% NO_x with 10-15% natural gas. All performance goals were achieved.

Project Status:

The Ultra-Low NO_x Retrofit Boiler Burner project was successfully completed. New efforts have been initiated under the FIR Low NO_x Burner project to reduce NO_x levels to below 5 ppm and to demonstrate an application on a US Steel industrial boiler cofiring blast furnace gas, coke oven gas, or mixed fuels. For the Methane deNO_x – Biomass project, a performance database is under development, and work will continue on expanding the Methane deNO_x technology to other engineered-fuel applications.

Industrial Waste Processing (#825)

Contract #: 100-98-003 **Project #:** 3

Contractor: Gas Research Institute

Subcontractors: Changing World Technologies : MicroGas : Endesco Clean Harbors : LLC.

Project Amount: \$104,000

Contractor Project Manager: Ron Edelstein (847) 768-0889

Commission Contract Manager: John Sugar (916) 654-4563

Status: Completed

Project Description:

The purpose of this project is to develop energy-efficient processes that reduce the cost and energy consumption associated with the treatment and disposal of industrial, commercial, and residential waste streams. Major activities under this project are placed in two categories. The first focuses on a cement-lock technology process that will convert contaminated sludge into environmentally safe cement. This technology could reduce the disposal cost of contaminated materials by \$25 per ton. The second, an advanced Thermo-Depolymerization (TDP) process to convert organic waste into graphite and oil for industrial and commercial use, is in the early stages of development. If successful, a pilot test facility will develop data for full-scale waste reduction in food processing, petroleum, tires, plastics, municipal solid waste, sewage sludge, and animal husbandry.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by providing a process to convert contaminated sludge into environmentally safe cement.
- Improving the energy cost/value of California's electricity by reducing the energy used for disposal of contaminated sludge and organic waste by California energy consumers.

Proposed Outcomes:

1. TDP: Demonstrate the technical feasibility of direct conversion of organic wastes in the food, paper/pulp and tire industry to middle distillates, fatty acids and power.
2. Sewage Sludge: Design and construct a two-ton per day pilot plant for converting sewage sludge in the Seattle area.
3. Cement Lock: Produce a validated cement-locking process technology for a variety of contaminants and a first commercial site to prove the technology. Conversion of Resource Recovery and Conservation Act (RCRA) class III estuarine sediments to Portland cement.

Actual Outcomes:

1. TDP: A 7.5 tons per day (tpd) pilot facility located in the Philadelphia Navy Yard is operational and turbines are connected to the grid.
2. Sewage Sludge: GRI, microGas, Inc. and the city of Seattle teamed to build a 2 tpd pilot unit. The unit is operational. Data is being collected and the technology is under evaluation by the city of Seattle for incorporation into their Reton facility.
3. Cement Lock: A demonstration facility has been sited in New Jersey during the fourth quarter of 2000. The first commercial unit has been sold to Taiwan.

Project Status:

The project has been completed.

Laboratory Type Facilities

Contract #: 500-97-013 **Project #:** 7

Contractor: Regents - University of California

Subcontractors: Lawrence Berkeley National Laboratory

Project Amount: \$375,000

Contractor Project Manager: Karl Brown (510) 287-3330

Commission Contract Manager: Clint Lowell (916) 654-4554

Status: Completed

Project Description:

The purpose of this project was to provide new technology and applications knowledge to reduce the energy intensity and improve the performance of high-tech and laboratory-type facilities. Facilities of this type frequently house cleanrooms. Examples of California industries where high-tech manufacturing and research-type facilities exist are semiconductor, electronic, biotechnology, pharmaceutical, aerospace, medical and universities.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by improving the energy efficiency of an ever-growing sector of California's industry.

Proposed Outcomes:

Eight project components were identified. Each component has a goal to serve as the basis of a multi-year RD&D effort to improve energy efficiency in high tech buildings. We report on this year's objectives, outcomes, and conclusions for each project component and our progress towards reaching the goal. The eight project components and goals are:

1. Design Intent Documentation: Develop a methodology and a tool to capture design intent information and performance expectations for use throughout the building's life cycle.
2. Laboratory Fume Hood Containment: Reduce fume hood airflow requirements by at least 50 percent while improving hazard containment. An additional goal is to develop the containment technology for use in other industrial ventilation applications such as for semiconductor manufacturing.
3. Laboratory Airflow Design: Develop airflow design criteria and tools to optimize fan power consumption.
4. Field Studies/Performance Feedback: Develop a standard methodology for benchmarking complex laboratory facilities. Provide performance feedback to designers and operators.
5. Technology Transfer: Develop design guides, Web sites, workshops, and other technology transfer mechanisms.
6. Clean Room Benchmarking: Improve energy efficiency and performance of clean rooms through benchmarking across industries.
7. Clean Room Analysis Tools: Develop HVAC energy analysis and design tools for clean rooms.
8. Industry Liaison: Form collaborative alliances with industry organizations to assure success in the marketplace.

Actual Outcomes:

1. Design Intent Documentation:
 - Developed a first generation database in an MS Access to archive design intent information.
 - Captured design intent information from the UC Santa Cruz case study of the Design Guide.

2. Laboratory Fume Hood Containment:
 - Continued to develop and test a prototype low flow fume hood using a commercial hood as the base.
 - Continued to use CFD modeling to evaluate and improve performance.
 - Continued commercialization efforts including arranging for two field tests, and identification of institutional barriers to adoption of the new technology.
 - Option agreement signed with ATMI to develop and commercialize products for the microelectronics industry using the low flow containment ("air dam") technology.
3. Laboratory Airflow Design:
 - Initiated development of a computer program for modeling dynamic multi-fan airflow, including analysis of existing software tools that could reduce development time.
 - Developed an initial commercialization plan involving public goods funding, ASHRAE, and private sector software support.
4. Field Studies/Performance Feedback:
 - Continued laboratory benchmarking tool development including adding buildings and data to the database, and populating a second-generation database (in MS Access).
 - Analyzed the data and refined the performance benchmarks, and improved the reporting scheme.
 - Added listing of values for key performance parameters so they can be used in the design intent tool (see above) and compared to actual values when performance is tracked (BLISS).
 - An insufficient number of laboratories were studied to transfer additional information to the electronic Design Guide (see below).
 - Studied the opportunity to establish a World Wide Web interface to the database and reports, and concluded that this is the best implementation strategy.
 - Determined that collection of field data to populate the database is dependent on further funding, however, strong interest was shown by EPA to use the database in a national program (Laboratories for the 21st Century) which may provide a large source of laboratory benchmark data.
5. Technology Transfer:
 - Continued support of the electronic Energy Efficient Laboratory Design Guide – maintained a Web version, distributed floppy disks, continuously evaluated Guide and made appropriate revisions.
 - Continued case study of Guide's use on a new California laboratory and initiated second case study at UC Santa Cruz.
6. Clean Room Benchmarking:
 - Continued benchmarking work, including: refinement of metrics, and expansion of case studies.
 - Arrangements have been made with PG&E to begin a major data collection effort in FY2000.
 - Disseminated case studies on LBNL's clean room Web site.
7. Clean Room Analysis Tools:
 - Continued evaluation of clean room analysis tool needs and the potential enhancements to an existing computer-based energy analysis tool (potentially DOE-2.2).
 - Determined that although a technical need exists, designers are satisfied with their existing tools and have little incentive at the present to change.

8. Clean Room Industry Liaison:
 - Hosted a clean room workshop and published the proceedings which were distributed to all attendees.
 - Hosted two clean room design charrettes, one with Genentech and one with a major San Jose electronics company.
 - Attended and participated in numerous clean room industry forums to transfer knowledge, expand network, and build industrial relationships.

Project Status:

The project has been completed.

Materials Fabrication Industry

Contract #: 100-98-001 **Project #:** 28

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Terratech Corporation

Project Amount: \$336,600

Match Amount: \$1,876,879

Contractor Project Manager: Leo Svendsen (973) 263-0181

Commission Contract Manager: Brian Laan (916) 653-7963

Status: Completed

Project Description:

The purpose of this project is to address the challenges the materials fabrication industry is facing from tightening profit margins, competition from abroad, and stricter environmental regulations. These challenges are pressuring materials fabricators to cut costs and improve productivity, quality, and efficiency to remain competitive. The materials fabrication industry is responsible for giving form to most of our modern conveniences it makes the metal and rubber products, machinery, printing and publishing, furniture, and plastics. An enormous amount of energy goes into producing this range of goods, over 262 billion kWh per year. In addition, it is estimated that another 700 billion kWh of secondary load can be attributed to these sources within 100 miles of the primary plant(s).

EPRI's Materials Fabrication target offers technical applications, services, and communication and marketing tools that can help the materials fabrication industry meet these competitive challenges. Technologies like transverse flux heating, infrared curing, and powder coating can improve productivity, product quality, and environmental performance. In addition, EPRI's plant surveys and demonstrations provide information and innovative approaches to re-tailor traditional processes and cut costs in this competitive sector expertise with real customer solutions to real problems.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing technologies and methods to increase energy efficiency for materials fabrication industries.
- Improving the environmental and public health costs/risks of California's electricity by providing technologies and methods that reduce emissions of materials fabrication industrial sites.

Proposed Outcomes:

1. Support the use of infrared and ultraviolet powder coatings by providing technical information on these processes.
2. Support the use of electric infrared heating (IR) in industrial processes by providing market analyses and technical, economic, and performance information.
3. Conduct a Tailored Collaboration entitled "Develop and Deliver Seminar and Demonstrations of UV Powder Coatings."

Actual Outcomes:

1. Infrared and ultraviolet powder coatings.
 - Tech briefs were published on improving powder coating performance, curing polyurethane powder coatings in IR ovens, and on curing powder coatings on ATV accessories.

- A report was published on UV curable coatings to assist California fabricators and energy service companies in better understanding UV curing.
- A cost-comparison worksheet was developed for induction curing of coatings.
- 2. Electric infrared heating.
 - Tech Application Sheets were published, describing real-world applications of advanced materials fabrication technologies, including impacts on costs, energy consumption, emissions, and productivity. Applications include aluminum aging, drying and curing of silk, steel strapping, cryogenic processing of metals, and injection molding.
 - Guidelines were published to support the sales and marketing of induction heating to industrial customers.
 - Software was developed for estimating and comparing the operating costs of high-temperature heating options.
 - A technical report was published on reducing energy consumption and increasing productivity in the thermal processing of metals.
 - Twenty-three industry profiles were published, describing issues, concerns, processes, energy use, and opportunities for increasing use of advanced technologies. Industries include automotive stamping, canned fruits and vegetables, carpets and rugs, computers and office equipment, copper foundries, iron and steel foundries, meatpacking, farm machinery, hospitals, petroleum refining, and pulp and paper mills.
 - A monthly newsletter was published on developments in EPRI materials fabrication research.
- 3. A series of five seminar and demonstrations were held at Sacramento, San Jose, Los Angeles, Irwindale, and San Diego to present information on dry powder coatings cured by infrared or ultraviolet light. The sessions included technical presentations and equipment demonstrations. In addition collateral materials were produced, including the Technology Guidebook for Electric Infrared Process Heating.

Project Status:

The Commission's participation in this target ended as of December 31, 2000.

Materials Production Industry

Contract #: 100-98-001 **Project #:** 32

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Carnegie Mellon University : Edison Technology Solutions/Southern California Edison : Taratec Corporation : TU Electric Company

Project Amount: \$268,800

Match Amount: \$1,553,303

Contractor Project Manager: Leo Svendsen (973) 263-0181

Commission Contract Manager: Brian Laan (916) 653-7963

Status: Completed

Project Description:

The purpose of this project is to help the materials production industries have access to new, low-cost energy and energy efficient processes. Materials production industries (steel, aluminum, foundries, glass and cement) represent the largest sector of power demand in the industrial market. These markets, important to California's future, need to have access to low-cost energy and energy efficient processes to help lower energy-related manufacturing costs and to keep these plants in California. EPRI provides access to new or existing technologies to reduce energy use and energy bills, improve productivity, lower product cost, and improve product quality. Limited resources are available to help individual plants, particularly for evaluating new electrotechnologies. The Commission can use EPRI's resources as a source of information, data, technical expertise, and tools to help California industry thrive.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity through technologies that reduce raw material waste, reduce total energy use, increase product output per unit of energy needed, and reduce the total cost of business operations.
- Improving the environmental and public health costs/risks of California's electricity by applying technologies that reduce combustion processes, thereby lowering overall combustion emissions and reducing California's contribution to global climate change.

Proposed Outcomes:

1. Conduct research to support application of new and existing energy efficient technologies for California's materials production facilities.
2. Provide information and communication tools to increase the potential application of energy efficiency technologies in California's materials production facilities.

Actual Outcomes:

1. Research to support application of new and existing technologies.
 - A comparison was conducted of all-electric versus oxy-fuel glass melting to identify the benefits and concerns of conversion to electric glass melting. Findings were published in a report.
 - An investigation was undertaken to identify new market niches for a microwave technology developed to separate water-oil emulsions from the metal particulates in steel mill sludge. Findings, published in a report, will assist industries in recycling metalworking fluid and improving waste management practices.
 - A software model was developed to compare the costs of electric induction heating versus traditional gas-fired heating systems in the aluminum and steel industries.
 - A software model was developed for analyzing electronic arc furnace dust recycling.

- An analysis was conducted and reported on the effect of melting furnace type on the cutting machinability of gray iron.
- 2. Communication tools.
 - A report was produced on power quality problems associated with induction furnaces.
 - Information was published on the cost and environmental advantages of electrically powered conveyor systems versus diesel-powered haul trucks for material handling in mining operations.
 - Industry segment profiles were published on the powder metal parts and products industry and the fiber-based composite materials industry. Profiles reviewed the industries' characteristics, energy usage, production statistics, and market structure.
 - Information was provided on indoor air quality (IAQ) issues for foundries to assist the CEC in better understanding the rules and regulations associated with foundry IAQ.
 - Information and guidelines were published on the costs, energy efficiency, emissions, and production advantages of nonferrous metal melting electrotechnology.
 - A monthly newsletter was published covering technology developments, applications, and trends in the aluminum industry.
 - A monthly newsletter was published updating developments in the steel industry.
 - A monthly newsletter was published providing updates and news of EPRI projects related to materials production industries.

Project Status:

The Commission's participation in this target ended as of December 31, 2000.

Municipal Water and Wastewater Industry

Contract #: 100-98-001 **Project #:** 31

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Nitrate Removal Technologies : PERKINS DBA DAVID : RICE International : American Water Works Research Foundation : Black & Veatch : BOC Group, Inc. : Camp Dresser & McKee : CH2M Hill, Inc. : City of Houston, Texas : Clean Earth Technologies : Edison Technology Solutions/Southern California Edison : ESG International, Inc. : Hazen & Sawyer : HDR ENGINEERING, INC. : Kennedy/Jenks Consultants, Inc. : Malcolm Pirnie, Inc. : McAllen Public Utilities : ProWrite, Inc. : Tennessee Valley Authority : University of Missouri, Columbia : University of New Hampshire : Washington State University : West Chester Area Municipal Authority

Project Amount: \$252,000

Match Amount: \$2,986,184

Contractor Project Manager: Keith Carns (314) 935-8598

Commission Contract Manager: Wendell Bakken (916) 654-4042

Status: Completed

Project Description:

The purpose of this project is to provide technology and information on the cost effective use of energy to deliver clean drinking water, treat, dispose, and reuse wastewater, and dispose of residuals, biosolids, and brines. Advanced technologies include ozonation of drinking water, freeze/thaw waste conditioning, and ultraviolet (UV) disinfection techniques. The available supply of high quality water and sufficient wastewater treatment capacity are essential to future economic development of a region. On average, municipal water/wastewater industries comprise approximately 3 percent of the total electrical load (approximately 75 billion kWh per year). Due to population increases, the load for these industries is projected to increase by more than 20 percent over the next 15 years. Of key interest in this EPRI target is the need for clean drinking water and the use of water for industrial purposes.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing advanced technologies to cost effectively deliver clean water, and process and dispose of wastes derived from water treatment.
- Improving the public health costs/risks of California's electricity ratepayers by providing technologies that effectively purify water and wastewater.

Proposed Outcomes:

1. Increase the potential for application of ozonation of drinking water.
2. Increase the potential for application of advanced technologies for water and wastewater treatment.
3. Increase the potential for application of Pulsed UV for Water/Wastewater Disinfection.

Actual Outcomes:

1. Ozonation.
 - A progress report was published on a feasibility study on the use of ozone disinfection system at a large-scale wastewater treatment plant.
 - A document entitled Issues for Ozone for Drinking Water Treatment was published.
 - A technical report was published on minimizing the operating and capital costs of ozonation systems.

- A tech brief was published on ozone uses in small drinking water systems.
 - A report was published on Phase III of the Ozone Efficiency Project, which focused on optimization of ozone use during pre-design and design of water treatment systems.
2. Advanced technologies for water and wastewater treatment.
- A manual was published on membrane technologies for municipal water treatment that describes different membrane technologies similarities and differences, operational parameters, and aspects to consider.
 - Tech briefs were published on results of a project conducted with California water districts to investigate ozone use, desalination, reclaimed water technologies, membrane treatment of industrial wastewater, and denitrification of potable drinking water.
 - A CD-ROM was produced with an overview of water and wastewater treatment processes.
 - A generic model was developed for an energy and water quality management system.
 - A microporous membrane pretreatment and reverse osmosis desalination system was tested in a California wastewater reclamation project, and results were reported.
 - A report was published on VARIO-ROTM, a promising pumping and energy recovery technology for the reverse osmosis desalination process.
 - A tech brief was published on technologies for improving water desalination.
 - A document was published on desalination of brackish water and seawater.
 - A tech brief was published on water treatment plant residuals.
 - A report was published on the status of small-system, onsite decentralized wastewater treatment plants in the United States.
 - A workshop was conducted entitled "Promising Electrotechnologies to Enhance Water and Wastewater Treatment."
3. Pulsed Ultraviolet Light for drinking water disinfection.
- A report was published on pulsed UV light for drinking water disinfection and membrane fouling control.
 - A tech brief was published on the results of research conducted by the Metropolitan Water District of Southern California to evaluate the effectiveness of pulsed UV light for drinking water treatment.
 - A progress report was published on pilot testing of four different UV reactor configurations and three types of lamps for potable water disinfection.
 - A report was published on a UV demonstration at a wastewater treatment plant in Poughkeepsie, New York.

Project Status:

The project has been completed.

Power Quality for Improved Industrial Operations

Contract #: 100-98-001 **Project #:** 6

Contractor: Electric Power Research Institute (EPRI)

Subcontractors: Duke Energy Corporation : Electrotek Concepts, Inc. : EPRI PEAC Corporation : Global Software Resources, Inc. : Jacobs Engineering Group, Inc.

Project Amount: \$788,346

Match Amount: \$2,995,914

Contractor Project Manager: Sid Bhatt (650) 855-8751

Commission Contract Manager: Pramod Kulkarni (916) 654-4637

Status: Completed

Project Description:

The purpose of this project is to address problems of power quality for the modern, highly automated industrial plants in California that suffer from breakdowns and lost productivity due to voltage, current, or frequency variations within the plant. Power quality (PQ) problems on the utility lines or within an industrial plant can cause equipment failure, damaged products, unsafe working conditions, and wasted time, material, and labor. With today's global competition and increasingly sophisticated and computer-controlled manufacturing processes, industries demand a reliable source of electricity. Energy companies and customers alike need up-to-date information, technology, and training if both are to remain competitive.

This target offers a complete package of data, information, and knowledge addressing power quality concerns at industrial plants. EPRI products are designed to reduce analysis and engineering time, labor costs, and investigation expenses. Information and training programs serve to educate utility and industrial customer power quality personnel on how to avoid power quality problems by characterizing specific systems. Economic analysis of solution options allows California industry to select the right solution for the PQ problem at hand at the right cost.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by helping California industry more quickly identify the causes of power quality problems, understand the various options for solutions and costs of implementation, and then select the option that best fits the need.
- Improving the energy cost/value of California's electricity by reducing the impacts of power quality problems by providing cost-effective and fast solutions.

Proposed Outcomes:

1. Provide experiential data on past power quality problems and solutions.
2. Provide information services and support for industrial-sector power quality.
3. Provide a power quality solution package for voltage sags.
4. Focus power quality improvement efforts, resources, and services more effectively for specific industries.
5. Evaluate retrofit capabilities for hardening drives/process equipment to increase the immunity of industrial customers to voltage sags and interruptions.
6. Provide information on field demonstrations of power quality mitigation technologies at industrial customer sites.
7. Provide information on industry-based power quality standards.
8. Conduct a Tailored Collaboration entitled "Characterizing Power Quality and Specifying Solutions at a Food Processing Plant" to document, evaluate, and identify solutions for power quality problems experienced by food processors.

9. Conduct a Tailored Collaboration entitled "Characterizing the Impact of Power Quality on Programmable Logic Controllers with and without Power Conditioning Devices" to develop technical guidelines to quantify the benefits of power conditioning with programmable logic controller (PLC) systems.
10. Conduct a Tailored Collaboration entitled "Power Quality Solution Guidebook for Industrial Customers" to develop a technical guidebook to help consumers identify power conditioning and other mitigation technologies that can increase industrial process immunity to voltage sag disturbances.

Actual Outcomes:

1. Experiential information.
 - A brochure and case studies were provided to help industrial customers improve ride-through and immunity to everyday disturbances.
 - An application brief was provided on application of large flywheel energy storage systems for premium power.
 - A review was completed of new harmonic mitigation technology application case studies.
2. Power quality information and services.
 - Workshops and training sessions were offered on Power Quality for Business Professionals, Power Quality Business Opportunities, Power Quality Technical Training, Power Quality Basics, Intermediate Technical Training, Advanced Power Quality, Residential Shocking, and Adjustable Speed Drive Applications.
 - A quarterly newsletter was published on power quality issues and solutions, and a monthly newsletter was published on EPRI power quality activities and events.
 - Access was provided to power quality expertise, training, and technical support from the EPRI PEAC Corporation and the EPRI Adjustable-Speed Drive Demonstration Office.
3. Version 1.0 was released of EPRI's Industrial Voltage Sag Investigator software tool that allows users to assess problems and identify solution options.
4. Information for specific industries.
 - A comprehensive guidebook was published on power quality mitigation technologies, including a description of each mitigation tool and its application.
 - An Industrial Design Guide, a browser-based information service, was established to provide a guide to power quality issues and case studies on specific processes.
5. Retrofit capabilities for increasing immunity to power quality disturbances.
 - A step-by-step application guide was published for increasing industrial equipment immunity.
 - An overview was provided of embedded solutions for reducing the sensitivity of equipment to power quality variations, focusing on technical and market issues associated with equipment modifications by original equipment manufacturers to improve equipment tolerance to power quality events.
6. Information on field demonstrations.
 - A screening tool was developed for conducting technology demonstrations for industrial customers to increase understanding and build customer confidence in products.
 - A technical document was published that provides step-by-step directions for conducting harmonic mitigation demonstration projects for industrial customers.

7. Up-to-date information was provided on domestic and international industry standards activities, including NEMA, SEMI, NEC, and others.
8. Power quality was monitored at a selected food processing plant, data were analyzed using the EPRI Power Quality Diagnostic System Software, and findings were published in a report.
9. Tests were conducted with and without power conditioning equipment—including testing for voltage sags, capacitor switching transients, and lightning-induced transients. Findings were published in a report.
10. The Industrial Power Quality Guidebook was published, with associated web-based HTML pages.

Project Status:

The Commission's participation in this target is ongoing.

IAW Projects Completed in 1999

Food Service Technology Center

Contract #: 500-97-010 **Project #:** 7

Contractor: Pacific Gas and Electric Company

Subcontractors: Fisher-Nickel, Inc. : Fisher Consulting : Food Service Technology Center.

Project Amount: \$350,000

Contractor Project Manager: Grant Brohard (415) 973-0106

Commission Contract Manager: Obed Odoemelam (916) 654-4171

Status: Completed

Project Description:

This purpose of this two-part project was to establish a standard method for measuring emissions from commercial kitchens, and methods for reducing such emissions within the industry. The second part is aimed at establishing industry-wide design guidelines for achieving and maintaining optimum performance and energy efficiency in commercial kitchen ventilation systems. This project is conducting this research in response to the growing concern about the impact of emissions from the large number of commercial kitchens in California.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by identifying ways to optimize the energy used for ventilation in commercial kitchens and reducing the health risks associated with emissions from these kitchens.

Proposed Outcomes:

1. Maximize energy efficiency in commercial kitchen ventilation systems (CKV) in a way that will maintain the health and safety functions of the CKV system.
2. Develop uniform test methods for characterizing emissions with regard to composition and major sources.
3. Develop effective emission control approaches.
4. Provide information for kitchen designers, mechanical engineers, food service operators, property managers, and maintenance people about achieving and maintaining optimum performance and energy efficiency in CKV systems.
5. Provide information applicable to new construction and, in many instances, retrofit construction.
6. Disseminate research through workshops and publications for the benefit of the industry and regulatory agencies concerned about these emissions.
7. Develop industry-wide guidelines for designing, installing and operating ventilation systems in terms of health and safety, effectiveness and energy efficiency.

Actual Outcomes:

1. Testing portion of the project (instrument calorimeters for particulate matter and for heat gain measurement) was completed. These tests were conducted to establish a site for future testing purposes.
2. Two new approaches to minimize emissions were developed, tested and evaluated. The first approach uses grease extractors to minimize emissions during the cooking process. The second approach uses catalysts in hoods for the removal of Particulate Matter resulting from the cooking process. Both of these emission control approaches were determined to be successful and have the potential for future use in the food service industry.
3. A workshop on emissions measurement and control was held for the food service industry in San Francisco. The purpose of the workshop was to establish emission factors

- used for measuring emissions from commercial kitchen ventilation systems (CKV) systems. Designers and manufactures from all over the country participated in this conference. Workshop proceedings were provided to interested parties.
4. A Commercial Kitchen Ventilation System Performance Evaluation and Optimization workshop was held to demonstrate the methods developed to evaluate the efficiency of CKV systems. A report on the evaluation methods was prepared and made available to interested parties.
 5. A computer model designed to conduct cost assessments for commercial kitchen ventilation systems was developed and made available for industry-wide use. This model is designed to consider specific conditions and needs for individual commercial kitchens and allow for cost-effective CKV system designs.
 6. A draft of industry-wide guidelines for designing, installing and operating ventilation systems in terms of health and safety, effectiveness, and energy efficiency has been completed, but because of unexpected circumstances, a no-cost time extension to complete the final guidelines was requested and granted.
 7. Final report is expected January 2000 and will be available to interested parties from the contract managers.

Project Status:

The project has been completed.

Integrated Agricultural Technology

Contract #: 500-97-012 **Project #:** 3

Contractor: Edison Technology Solutions/Southern California Edison

Project Amount: \$320,000

Contractor Project Manager: Lory Larson (626) 812-7161

Commission Contract Manager: Ricardo Amon (916) 654-4019

Status: Completed

Project Description:

This project demonstrated the use of ozone as a substitute soil fumigant; ozone as an alternative to aqueous toxic chemicals for fungi control in fruit packing plants; low-temperature, controlled-ventilation in storage facilities; innovative manure treatment technologies; and irrigation scheduling systems.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of emerging electrotechnology applications in agriculture and improving the environment.
- Improving the public health costs/risks of California's electricity by replacing toxic chemicals with cleaner electrotechnologies in the fruit industry.

Proposed Outcomes:

1. Determine the effectiveness of ozone as a preplant soil fumigant to destroy a variety of soil-borne microorganisms.
2. Determine the effectiveness of ozone as a disinfectant and fungicide in aqueous solutions used for fruit storage and packaging operations and ozone treatment for discharge water quality purposes.
3. Determine the effectiveness of ozone as a post-harvest fumigant to control insect infestation of fresh and dried fruits and vegetables.
4. Demonstrate the viability and practicality of a low-cost, temperature-controlled storage facility to inhibit insect infestation of stored fruit. Test the effectiveness of plastic film bin liners to control insects in stored prunes. Develop baseline data on Indianmeal moth populations near drying and storage facilities.
5. Determine the functionality of an innovative biological treatment device to manage the disposal of liquefied animal wastes.

Actual Outcomes:

1. Ozone treatment demonstrated substantial improvements and crop yield or plant vigor compared to untreated controls in all crops tested, except peaches. Soil treatment with ozone decreased soil pathogens and increased nutrient availability.
2. From 95 to 100 percent of all 8 fungi tested were killed in 2 minutes of contact time with the ozone treatment. None survived 3 minutes of contact. Higher doses of ozone were required to kill pathogens on fruit surfaces than those needed to kill spores in water. Ozone significantly reduced gray mold incidence on table grapes, but its efficacy was irregular. Ozone was inferior to sodium hypochlorite, sodium bicarbonate, and ethanol as a fungicide. The control of pathogens inoculated into wounds in citrus fruit failed even after prolonged treatment with very high ozone concentrations in water.
3. Table grapes, citrus fruit, and strawberries were not visibly injured by the ozone treatments evaluated. In strawberry wash water, ozonation for 3 hours greatly reduced microbe populations, moderately reduced biochemical oxygen demand, chemical oxygen

- demand, and suspended solids, did not reduce total organic carbon, and increased total dissolved solids.
4. Four to 6 hours of exposure to ozone concentrations of 300 to 500 parts per million were needed to kill Indianmeal moth larvae and diapausing codling moths. Chambers designed for ozone fumigation will need to be made of materials that can withstand the corrosive action of continuous exposure to high concentrations of ozone. Therefore, results of this first phase are preliminary and more research is required.
 5. The controlled ventilation and evaporative cooling system was too expensive to install, considering it would only provide safe storage temperatures for 7 months of the year. Prune quality was determined to be excellent after 1 year in storage in plastic bags. Moisture content of the prunes did not change during storage, and the fruit was exceptionally free of sugaring and mold compared to fruit stored conventionally. Bins with liners must be stored in an environment that prevents significant diurnal temperature fluctuations. Baseline data collected indicated that Indianmeal moth is the species of most concern for prune storage. The liner storage system will work well only if fruit is virtually free of infestation before being placed in the liners.
 6. The sequencing batch reactor was determined an effective biological reactor for treating dairy wastewater. A two-stage sequencing batch reactor system is recommended over a single-stage system if nitrification is desired. The two-stage system was capable of achieving near-complete conversion of ammonia to nitrite and nitrate in the dairy wastewater.

Project Status:

The project has been completed.

Low Dross Aluminum Melter

Contract #: 500-97-012 **Project #:** 2

Contractor: Edison Technology Solutions/Southern California Edison

Subcontractors: TIMCO, Division of TST, Inc. : Paul Wurth, Inc.

Project Amount: \$450,000

Match Amount: \$2,650,000

Contractor Project Manager: Mazen Sadeq (626) 815-0513

Commission Contract Manager: Dennis Fukumoto (916) 653-6222

Status: Completed

Project Description:

The purpose of this project was the demonstration of an advanced DC-Arc Plasma furnace designed to melt aluminum scrap material for the reuse market within a controlled, oxygen-starved environment that prevents the formation of aluminum oxide (dross) and reduces the volume of process waste material.

This project supports the PIER Program objectives of:

- Improving the energy cost and value of California's electricity by demonstrating a technology that increases energy efficiency by 80 percent for recovering scrap aluminum for reuse.
- Improving the environmental and public health costs/risks of California's electricity by demonstrating a technology that yields the following advantages over gas-fired reverberatory furnaces.

Proposed Outcomes:

The objective of this project was to design, fabricate, and place into operation a five-ton DC Plasma Arc melter that meets typical commercial melting requirements of the scrap aluminum recycling industry by:

1. Upgrade the one-ton Wabash unit and apply various lessons and design improvements gained from the experimental operation of that unit.
2. Demonstrate the commercial viability of the DC Plasma-Arc melting technology for the aluminum reprocessing industry.
3. Design and build a 5-ton unit at a commercial site.

Actual Outcomes:

Design requirements for modification of the Wabash unit were prepared by the Technical Team under the direction of ETS. The Wabash upgrade activities included:

1. Tightened furnace seals to lower dross formation.
2. Designed a mechanical stirring capability.
3. Relocated furnace electrodes to increase furnace efficiency.
4. Improved furnace feed system to increase throughput and reliability.
5. Developed dross removal techniques that reduce O&M costs.
6. Demonstrated conversion of dross into useful steel-making additive.
7. Optimized the refractory practice, argon flow rate, furnace temperature and process cycle times.

Water and Wastewater Electrotechnologies

Contract #: 500-97-012 **Project #:** 1

Contractor: Edison Technology Solutions/Southern California Edison

Subcontractors: Metropolitan Water District of Southern California : Orange County Water District : Electric Power Research Institute (EPRI)

Project Amount: \$410,000

Contractor Project Manager: Lory Larson (626) 812-7161

Commission Contract Manager: Wendell Bakken (916) 654-4042

Status: Completed

Project Description:

The purpose of this project was to develop electrotechnologies which can produce new supplies of reliable and affordable drinking water, reduce electrical use to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes.

This project supports the PIER Program objective of:

- Improving environmental and public health costs/risk of California's electricity by possibly eliminating some conventional, chemically-intensive water treatment techniques and by helping to avoid transfers of water from environmentally sensitive areas in northern California to southern California.

Proposed Outcomes:

1. Demonstrate Colorado River Water (CRW) salinity reduction measures using reverse osmosis (RO) and capacitive deionization (CDI) with carbon aerogel.
2. Demonstrate the use of pulsed UV for disinfection and membrane biofouling control.
3. Investigate the formation and control of bromate during ozonation.
4. Study the disinfection of reclaimed wastewater with UV.
5. Evaluate the performance of low-pressure membranes.
6. Demonstrate that high-energy injection (E-Beam) is an effective alternative for water treatment.

Actual Outcomes:

1. Both conventional treatment with and without ozone and biofiltration produced an effluent water quality suitable for use with RO. Significant energy savings can be realized with the use of ultra-low-pressure RO membranes over the previous generation of low-pressure RO membranes however, large diameter RO elements are required for membrane technology to be implemented on a large scale. Carbon aerogel CDI technology has great potential, but the technology requires more development. Future CDI evaluations should be conducted at bench scale.
2. Pulsed UV disinfected up to 99.99 percent of targeted virus and bacterial and would be significantly less costly than ozone or membrane Cryptosporidium reduction technologies. This technology could be an additional barrier to pathogenic organisms in drinking water treatment.
3. Lowering pH before ozonation was effective in reducing bromate formation, but the technology is expensive compared to chlorination because of the large chemical dosages of acid required for pH control. Ammonia is a promising bromate control strategy for the Colorado River water at ozone doses required for enhanced Cryptosporidium disinfection. Hydrogen peroxide is not an effective bromate control strategy at the ozone doses required for 90 percent inactivation of Cryptosporidium.

4. Ultraviolet disinfection is a viable alternative to adding chlorine to wastewater in the presence of ammonia for disinfection of reclaimed wastewater for non-potable reuse, and UV is much more effective in destroying bacteria. A 99.99 percent inactivation of indigenous coliphage and a 99.99 percent virus inactivation at the pilot plant was achieved.
5. Ease of reclaiming water decreased as the quality of the feedwater decreased. Generally, microporous membrane permeability decreased as the concentration of suspended solids and biochemical oxygen demand in the feed water increased. Biological Oxygen Demand (BOD) can be used as a measure of the extent to which the water is polluted with organic compounds.
6. High energy electron beam injection is an effective alternate water treatment method by meeting or approaching Maximum Containment Levels (MCLs) on a variety of priority contaminants. Additionally, costs to install and operate the system are competitive and potentially much lower than conventional and other emerging alternates and treatment on MDMA, an organic carcinogenic contaminant, showed effective removal rates at costs lower than existing chemical destruction technologies.

Project Status:

The project has been completed.